FLIGHT
and
The AIRCRAFT ENGINEER

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The Outlook

Size and Weight

IN one way and another, size has become prominent both in the news and in theoretical speculations during the last few months. Our large four-engined bombers have taken part in the huge raids on Germany, and have acquitted themselves well. When the "big-bomber programme" was disclosed there were many who feared that we had committed ourselves to a policy which might prove to be mistaken. The huge four-engined bomber, it was said, was vulnerable, partly because of its size, which would make it an easy target for anti-aircraft fire, and partly because an aircraft of such weight and proportions could not be very manœuvrable. The latter fear has certainly not proved well founded. The difference, in this respect, between the medium-size twin-engined bombers and the four-engined has not been found very great, and the heavy armament carried by the large bombers has enabled them to do quite a lot of damage to enemy fighters.

As for large aircraft offering an easier target to anti-aircraft guns, we have never shared that view. If firing were done at point-blank range there might be something in the contention, but obviously it matters little whether the span of a machine, flying at 20,000ft., for example, is 80ft. or 110ft. The predictors work on a spot in the sky, and the size of that spot is rather immaterial.

When it comes to engines, there has been a good deal written about the large power plants of the future. Mr. John W. Morrison, in his article, "Power Units of the Future" in our issue of May 7th, visualised an H-type 24-cylinder engine developing 4,800 b.h.p. for take-off, and applauded Major Seversky's forecast of 8,000 h.p. engines and ranges of 25,000 miles!

The Square-cube Law

LAST week, in our Correspondence columns, Dr. Lockwood Taylor pointed out that engines are subject to the same fundamental laws as those which govern the weight of aircraft, and that the so-called "square-cube law" applies. This law, it may be recalled, asserts that whereas wing area increases as the square of a linear dimension (span, for example), the weight increases as the cube.

In the early days of flying that fundamental law was often quoted as proof that aircraft could never be really large; their structure weight, as a percentage of the gross weight, would become prohibitive. That argument was perfectly sound, and the fact that very large aircraft have been built with a very good ratio of gross weight to structure weight does not disprove the validity of the "square-cube law." What those who argued on it overlooked was that the law stipulates "geometric similarity"; that is to say, the law is based on the assumption that every part of the aircraft is enlarged to the same scale. In actual fact, of course, this is never done. Mr. Handley Page was probably the first to discover that when the size of aircraft increases there are all sorts of possibilities for weight-saving. Certainly he pointed that out in a paper to the Royal Aeronautical Society during the war 1914-18, when he had built the large 0/400 biplane bomber.

With the introduction of all-metal construction, and more particularly stressed skin construction, much weight can be saved in large aircraft by the fact that the very size of the machine makes it possible to use gauges of sheet which are just right for the loads to be carried; in smaller aircraft many sheets have, for practical

reasons, to be thicker than needed purely for load-carrying purposes.

Another factor which may well play an important part in the evolution of the large aircraft of the future is the thick wing. We have by no means reached the limit in wing thickness, and although the thick wing is generally thought to offer greater drag than the thin, there are circumstances when it pays to use it, and when the weight save is more important than the extra drag.

One important advantage of the thick wings is that it provides a lot of extra space. In the modern four-engined aircraft, with tanks in the wings, wells for the undercarriage wheels, and other paraphernalia, there is precious little space left, but an increase in thickness-chord ratio would have a marked effect on the tank capacity, for instance.

In the case of engines, Dr. Lockwood Taylor comes to the conclusion that there is an optimum size (he does not state what it is), and that this can be increased by better design technique and improved fuels. However, he utters a word of warning against a too optimistic outlook on future engine size.

Aircraft experience has shown that the "square-cube law" can be "cheated" in several ways. It may well be that engine designers will also find ways of circumventing the law, alhough their task is not made easier by the fact that the airscrew has to be taken into account.

Midway

FROM Pearl Harbour to Midway Island is only some 1,300 miles geographically, but historically much more than six months separate the two. It was an American president who made famous the saying about fooling all of the people some of the time. It has fallen to another American president to prove the truth of the old saying. Thanks very largely to the resolute leadership of Mr. Roosevelt, the United States were not caught napping a second time.

When the grinning yellow apes attacked Pearl Harbour before war had been declared, the United States forces were unprepared. When Japan thought she could repeat Pearl Harbour at Midway Island she found a very different reception.

The fact that the United States has been able, so far as present information goes, to destroy two if not three Japanese aircraft carriers with their aircraft, and damage others, indicates that this time American air scouting gave timely warning of impending attack.

It would be well to bear in mind Admiral King's cautious statement that "the Japs haven't been defeated yet; they have withdrawn." But one is entitled to rejoice at the damage inflicted on the enemy, and to hope that good news will also be heard of the engagement off Dutch Harbour.

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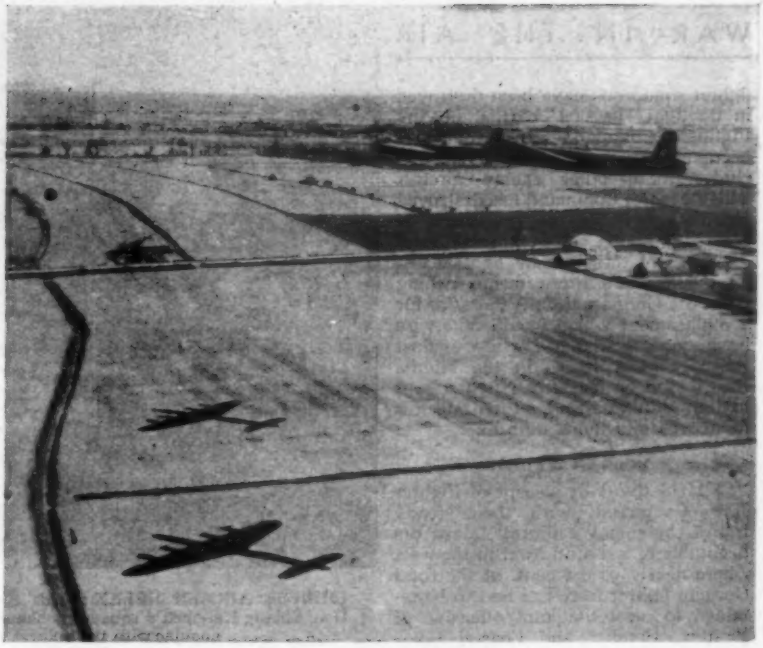
The United Nation Conference on air training in Ottawa. At the head of the table are Mr. W. L. Mackenzie King, Prime Minister of Canada (left) and Mr. C. G. Power, Canadian Air Minister (right). Clockwise round the table are :— U.S. Assistant Secretary of War for Air; Sir William Glasgow, Australian High Commissioner to Canada; Major-General T. H Shen, Commander of Chinese Air Forces in the U.S.; Mr. D. Steen, Norwegian Minister to Canada; Lieut. Col. C. Giebel, of the Netherlands; Group Captain Alexander Hessl of the Czechoslovakian Washington Legation; Group Captain Stefan Szmuk, Chief of the Polish Air Mission in Canada; Mr. Frank Langstone, New Zealand High Commissioner to Canada; Capt. Alfred Leondopolous, Belgian Minister to Canada; South African High Commissioner de Waal Meyer; and Captain Harold H. Balfour, M.P., British Parliamentary Under-Secretary of State for Air.

War in the Air

Bitter Lesson for Germans : Victims of Their Own Policy : Maelstrom in Libya



THREATENING SHADOWS: The clear cut silhouettes cast on the ground by these two Stirlings are heading towards Germany's war factories—prophetic shadows of the just retribution which has now begun to fall on the enemies of democratic freedom.

NO single subject has provoked more argument during the present war than strategic bombing; the columns of *Flight* have borne witness to the diversity of opinion on its value and, since civilians are bound to suffer, on its moral admissibility.

Germany started it and, thanks to our steadily improving night defences and the plain "guts" of our ordinary people, the indifferent results she gained seemed to support the contentions of those who threw doubts upon its value.

Now the boot is on the other foot, and Germany is beginning to learn the bitter taste of the medicine she was so ready to force down the throats of others. Britain, slow to get started, has gradually built up a bomber strength which is enabling us to show the Hun that if this strategic bombing game is played in really wholehearted fashion it can make serious inroads into the enemy's war production.

Reports say that very heavy casualties were inflicted in the Cologne raid, and doubtless Essen suffered in like proportion. Britons will not exactly gloat over the fact that a high proportion of the victims must necessarily have been civilians; many, in fact, will sincerely regret it.

But the R.A.F. has but taken up the challenge of the *Luftwaffe*, and it is too late for the Nazis to squeal that this is no sort of way to conduct a war. It is an air policy they themselves introduced, except that British bombs are aimed at war factories instead of cathedrals; the R.A.F. uses the trade directory, not Baedeker. A highly satisfactory feature of the "four-figure" raids on Cologne, Essen and the Ruhr was the low percentage of losses sustained by our bomber squadrons. It was found that raids carried out by 1,000 machines or more "saturate" the defences, with the result that opposition diminishes as the operations proceed. The cost to us of the Essen raid, for example, was less than 3.5 per cent.

The magnitude of the new scale of air assaults on the enemy war machine tends to overshadow the almost equally increased weight of Fighter Command's specialty in the form of daylight sweeps over occupied France. An official Air Ministry statement recently issued said that in a period of one month British aircraft made more than 7,700 flights during these daylight sweeps over enemy-occupied territory and, as the majority of the machines were fighters, it means that, on an average, no fewer than 250 of our fighter aircraft were engaged daily in this one phase of the air offensive.

"In the first five months of this year," the report continues, "the equivalent of 15 complete enemy

KITTY-BOMBER: In the Libyan battle, U.S. Kittyhawks are doing grand work in the hands of R.A.F. fighter pilots. This is being bombed up on an advanced airfield for a raid against Rommel's tanks.

WAR IN THE AIR

fighter squadrons have been destroyed in daylight 'sweeps' carried out by Fighter Command over enemy-occupied territory. This figure excludes those other enemy aircraft which Fighter Command has destroyed by night and in the protection of coastal shipping.

"Each of these enemy fighters lost on the Western Front means calling upon the German aircraft factories for a replacement which would otherwise have been available for use against Russia or our forces in the Middle East. And each German fighter sent to the Western Front means one less for Russia and the Middle East.

Second Front

"THUS the daily sweeps of Fighter Command, with their steady toll of the enemy's aircraft, mark the beginning of a second front in the west where nearly 50 per cent. of the total German fighter force has had to be retained to meet the joint offensive of Fighter, Bomber and Coastal Commands.

"Fighter Command's offensive is not being waged without loss to itself, though those losses bear no comparison to the enormous casualties which the *Luftwaffe* suffered over this side of the Channel in the Battle of Britain. Fighter Command on the offensive continues to shoot down more enemy fighters than it loses itself—no mean achievement for a force that is fighting on the enemy's side of the Channel and penetrating into occupied territory where one bullet in the engine may mean that the pilot has to bale out and his aircraft is lost.

"It may be suggested that the aircraft engaged on fighter sweeps might be more usefully employed in other more distant theatres of war; even that their presence there might have prevented some unpleasant reverses. In fact, if fighter sweeps were to be altogether abandoned, or had been abandoned months ago, it would not help to add one single fighter squadron to any of our overseas fighter forces. The bottle-neck to the reinforcement of fighter strength on distant fronts does not lie in any shortage of aircraft or pilots. It is entirely a matter of transport.

"As it is, there are no more fighters in this country than are necessary for two purposes—the defence of this country against air attack and against the possibility of invasion. To employ this force offensively, in damaging and hurting the enemy, as Fighter Command is at present doing, is obviously preferable to keeping that same force sitting on its airdromes waiting for the enemy to come and attack us from the air or invade us. It is also more in accord with the offensive spirit of the British people, and certainly of the spirit which animates the fighter pilots whose morale has never been higher than it is to-day when the initiative is theirs."

CHINESE AIRMEN RELAX: This scene in the aircrews' quarters of one of Gen. Chiang Kai-shek's squadrons shows that the inevitable gramophone is just as popular with the Chinese as with many of our airmen.

Middle East Maelstrom

A DECIDING factor in the phase of the Libyan battle last week was, beyond all question, the vital part played by the R.A.F. in close co-operation with the ground forces.

From dawn till dusk fighters, fighter-bombers and fast day bombers were hard at it gunning and bombing Rommel's tanks, transport and supplies, concentrations of enemy mechanised transport being attacked from low altitude. This alone cost the Germans something like 1,000 vehicles of various types, including petrol tankers, ammunition wagons and armoured cars, but the delay and confusion which the non-stop attacks caused the enemy were just as valu-

HAMPERING THE HUN: Here is an R.A.F. reconnaissance photograph of the Goodrich Rubber Tyre company's works at Gennevilliers, near Paris, which was producing for the German war machine until it was visited by the R.A.F. The extensive damage is clearly visible.

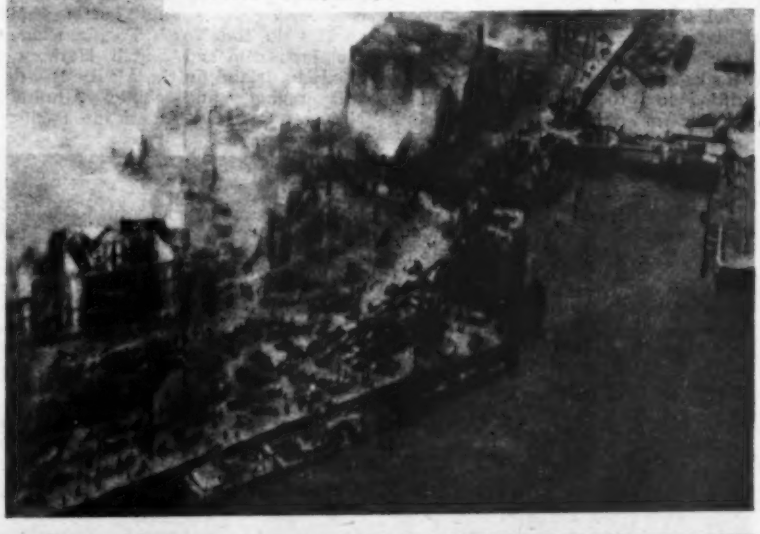
AND NOW?

Pertinent Extracts from German Air-bombing Propaganda of Two Years Ago

IN *Der Adler* (The Eagle), the *Luftwaffe's* propaganda journal printed in five languages, appeared these pictures and comments at the opening of the Battle of Britain. The centre photograph is of Rotterdam in flames, where thousands of people lost their lives in a matter of minutes. Below is portrayed the ruins of Warsaw—a feat of military arms of which the Germans are so proud. At the top left is a reproduction of the front cover of this vainglorious journal—the wording reads, "And Now England." Far be it from us to add, "And now Lübeck, Rostock, Cologne and Essen," but we are glad to see from the text that even in 1940 the Germans realised they could not teach Mr. Churchill anything.

Churchill Asked for It!

"WINSTON CHURCHILL has declared that he would defend London to the last stone. He will fight in front of London, in London, and behind London. Far be it from us to enlighten him on the insanity of his task. W. C. cannot be taught anything and is too old. Otherwise he must have known that in this war other men have used such high-falutin words but have changed their views in the presence of the ruins of their capitals. But then it was too late. We need recall only the Polish generals who declared Warsaw a fortress and thereby compelled its destruction, or the defenders of Rotterdam who thought they could dismiss the ultimatum of the commander of the German parachute and airborne troops. What these heroes achieved by their insane resistance Churchill evidently desires for England. The Luftwaffe *is ready."*



ENEMY AIR LOSSES TO JUNE 6th.

	Over G.B	Over Continent	Middle East
May 31	1	6	4
June 1	0	6	0
" 2	5	9	3
" 3	3	7	1
" 4	1	1	7
" 5	0	7	9
" 6	1	1	0
	11	37	24

Totals: North, 5,973; Middle East, over 3,929.

WAR IN THE AIR

BRITISH AIR LOSSES TO JUNE 6th.

	Over G.B. A'crft.	Over Continent B'brs.	Ftrs.	Middle East A'crft.
May 31	0	8	0	0
June 1	0	32	12	0
" 2	0	14	9	4
" 3	0	10	6	2
" 4	0	0	3	8
" 5	0	13	6	6
" 6	0	9	3	1
	0	86	39	21

Totals: North, 3,937; Middle East, about 1,215.

able to the Eighth Army as the actual destruction wrought.

Our losses in aircraft for the week have been remarkably light in spite of the fact that the Axis pilots had the advantage of being frequently able to choose their positions for attacking, from above, aircraft occupied in straf-ing ground troops. On the other hand, our Hurricanes, Tomahawks, Kittyhawks and Spitfires repeatedly smashed up fighter-escorted Stuka attacks on our own ground forces with trifling loss to themselves. And a number of our fighter pilots and bomber crews who were reported miss-ing have since regained safety and qualified for membership of the Winged Boot Club.

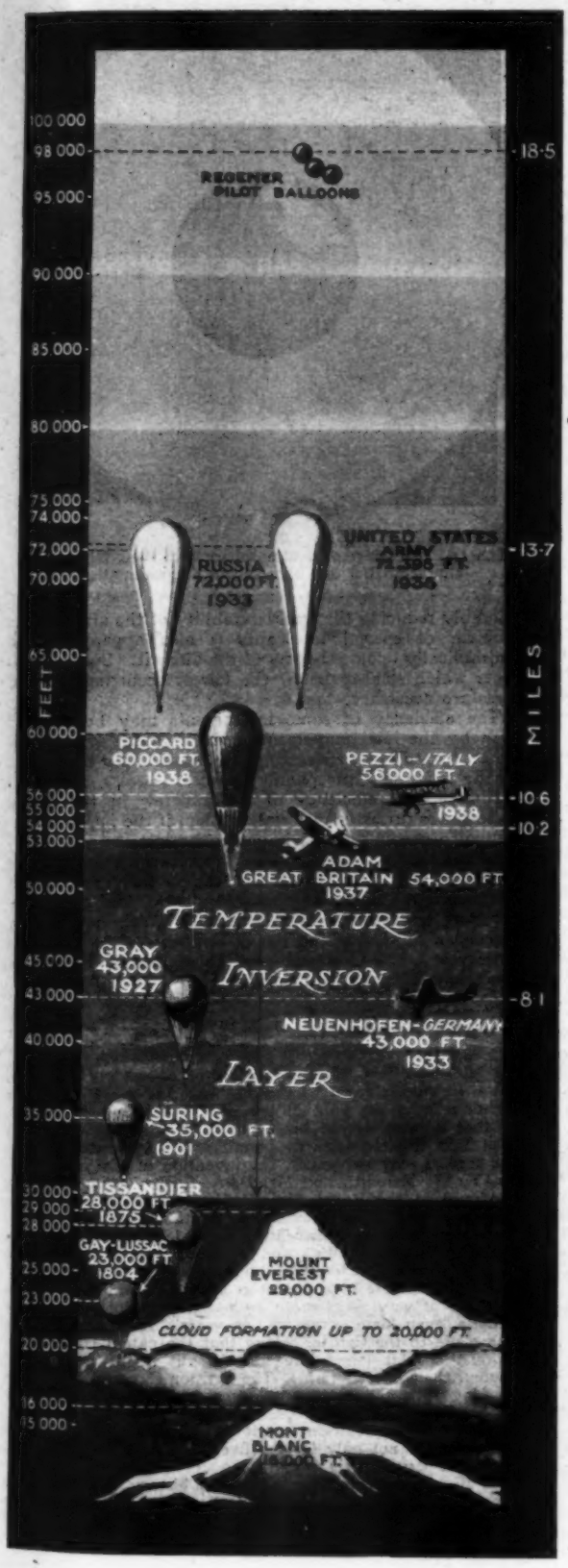
Dust storms have, on some days, practically grounded the air forces on both sides when, for a time, visibility was virtually nil.

Jap Reverse

THE smashing of the Japanese assault upon Midway Island came as a particularly heartening piece of news last week-end and, naturally enough, was hailed with delight in America, where it is regarded as a "bit of their own back" for Pearl Harbour. At the time of writing, however, this sea-air battle and another in the North Pacific where the Japs attacked Dutch Harbour, Unalaska Island, in the Aleutians, are still raging, and while Admiral Nimitz, C.-in-C. American Pacific Fleet, has referred to the Midway encounter as "a momentous victory in the making," Admiral King, C.-in-C. U.S. Fleet, said that in the North they had "none too clear a picture of what is going on."

Japanese losses off Midway Island were reported by Admiral Nimitz last Sunday as being two, or possibly three, aircraft carriers destroyed with all their aircraft, and one or two other carriers badly damaged and most of their aircraft lost. Three battleships, four cruisers and three transports were also substantially damaged.

THIS WAS COLOGNE: One of the first official photographs to be released of the widespread destruction caused by the R.A.F.'s 1,000 bomber raid on Cologne on the night of May 30th-31st. The tree-lined thoroughfare running up the centre of the picture is the famous Luxemburger Strasse, one of the finest in the city, now bordered by scenes of devastation. Note particularly the havoc caused in the railway depot and its immediate vicinity. Other parts of the city suffered a similar battering.



STRATOSPHERE FLIGHT

Advantages of High Altitude : Problems of Rarefied Air and Low Pressure : What the Human Body Requires : Effect on Aircraft Equipment

By DR. V. L. GRUBERG

THE attraction of high-altitude flight is that a much higher speed is possible in the thinner air with less expenditure of power. High-altitude flight is therefore more economical: already, at a height of some 33,000ft., an aircraft gains 40 per cent. in speed and 50 per cent. in range compared with a machine flying on the same quantity of fuel but at lower altitude. Furthermore, at these heights the influence of the weather ceases to exist, and the interference of thermic influences of the earth, bad weather, and icing no longer trouble the crew.

Last but not least, an aircraft flying at a high altitude has a wide radius in which to find a suitable place in the event of a forced landing, while it can also keep outside the range of modern A.A. guns.

The extension of human flight into the higher altitudes has been made possible by the unceasing research work of many scientists in different countries. Their observations have resulted in a detailed picture of the conditions and peculiarities of these regions.

The surface of the earth is enveloped by a mantle composed of two distinct layers of atmosphere. The lower extends from the immediate earth surface to a height of some six to ten miles and is known as the *troposphere*. The composition of this layer remains constant up to 7.4 miles, while the temperature decreases with the distance from the earth's surface at a uniform rate of 3 deg. F. for every 1,000ft. altitude. Thus at a height of approximately seven miles the temperature is something like −60 deg. F. or −40 deg. F., compared with 40 deg. F. or 60 deg. F. at ground level.

Conditions at Higher Altitudes

At this height the temperature remains largely constant, the contents of water vapour in the atmosphere is only 0.01 per cent. This layer, which extends to a height of some 30 miles, is known as the *stratosphere*.

Recent researches conducted by the staff of the Copenhagen astronomical and meteorological observatory deny, however, that with increasing altitude there is a gradual reduction of temperature. According to these observations the temperature rises slowly in altitudes from 18¼ miles and reaches 212 deg. F. at heights of between 37 to 43 miles. Prof. Regener, a German scientist, states that there is a layer of moderate warmth at 24 to 31 miles altitude, and that above 62 miles the temperature increases even further. Except for the rather rare appearance of the so-called "Mother of Pearl" clouds and the "Silver Blue Night" luminous clouds (which are composed of fine particles of dust), clouds do not exist in this region.

The troposphere and the stratosphere are not actually contiguous, for between them there is the *tropopause* in which the transition from one layer to the other is made. This region varies considerably in different parts of the world, and is lower in high altitudes (about seven miles) and highest above the Equator.

The relative composition of the air up to a height of

Higher and higher : this picture shows the many ascents which have been made to study the conditions of the higher altitudes.

STRATOSPHERE FLIGHT

some 45,000ft. remains essentially unchanged, and is 21 per cent. oxygen, 78 per cent. nitrogen, some 0.03 per cent. carbon-dioxide, and about 1 per cent. of inert gases of which the chief is argon.

For the smooth working of the human machine an adequate and *normally* rated oxygen supply is absolutely essential. Since the density of the air decreases with the altitude, the amount of oxygen which the body draws by breathing is considerably reduced. The resulting oxygen-want causes a complex of physiological and psychological symptoms. To start with, the affected person does not experience any harmful sensation and is only in a queer state comparable with alcoholism. Characteristic of this state is the complete absence of the critical sense, incapacity to perform simple and accustomed manual and mental functions, lack of co-ordination and control of the body; indeed, a real disintegration of the personality.

Another most important and significant effect of the reduced oxygen content of the air on the pilot is the reduced dark-adaptation. Since this is essential for the efficiency of a night-fighter pilot, it has been suggested that oxygen should be supplied to crews at a lower altitude at night. Ultimately, the deleterious effect of oxygen deficiency may bring the human machine to a complete standstill.

The Importance of Oxygen

Investigations carried out in laboratories reproducing conditions prevailing in higher altitudes have shown that up to 10,000ft. a normal individual is not affected by the reduction in oxygen supply. After this height there is a zone of adjustment where the body can compensate for oxygen deficiency by intensified respiration. After about 13,000 to 16,400ft. lies the lower limit of the zone of incomplete compensation, bound above by the critical line which leads into the zone of death due to altitude effect.

Because the reserve of oxygen in the human body amounts only to 400 c.c., or enough to maintain life for 1½ minutes, the permanent supply of oxygen is vitally important if the negative effects of the higher altitudes are to be prevented. This is achieved by addition of oxygen to the inspired air by means of a special breathing appliance, the oxygen mask. With modern fast-climbing aircraft the oxygen mask becomes a most necessary part of the equipment, not only for specific altitude performance, but for those eventualities in which the pilot may have to seek higher altitudes.

Oxygen masks are used as low as 15,000ft., and are an adequate source of oxygen supply up to an altitude of 30,000ft. Above this height the atmospheric pressure is so much below that at ground level that the oxygen saturation of the blood system is so low that even the breathing-in of pure oxygen is not sufficient.

In flights above 30,000ft. pressure suits or pressure cabins are, therefore, being used to compensate for the reduction in the outside atmospheric pressure. Originally, pressure suits were mainly used for various high-altitude record flights, but, since the higher regions are gradually becoming the normal zone of flying, pressure cabins are increasingly coming into service. They enable flights of longer duration to be made in high altitude in comfort.

Effect on Equipment

The effect of conditions prevailing at high altitudes is not limited to the power plant and the human body. The controls of the aircraft have to work under conditions entirely different from those for which they were originally designed and made. Very low temperatures cause control mechanism to bind at some places and loosen up at others because of the difference in contraction of different metals.

Fabric-covered rubber hose becomes so rigid and fragile that it frequently breaks under vibration and splits wide open. Lubricating oils tend to solidify at very low temperatures, and cause the stiffening up of controls, thus considerably reducing the manœuvrability of the aircraft. The problem of special lubricants is also apparent in all hydraulically operated parts of the aircraft. Special lubricants which solidify below the lowest occurring temperatures are necessary.

The two main layers of atmosphere with their temperature characteristics are here shown diagrammatically.

The efficiency of some instruments may be impaired both by the low temperature, which causes some plastic material used for their castings to become very brittle, and by the different atmospheric pressure.

Finally, the efficiency of the airscrew in the rarified atmosphere presents a special problem if the increased performance of the aircraft is not to be lost.

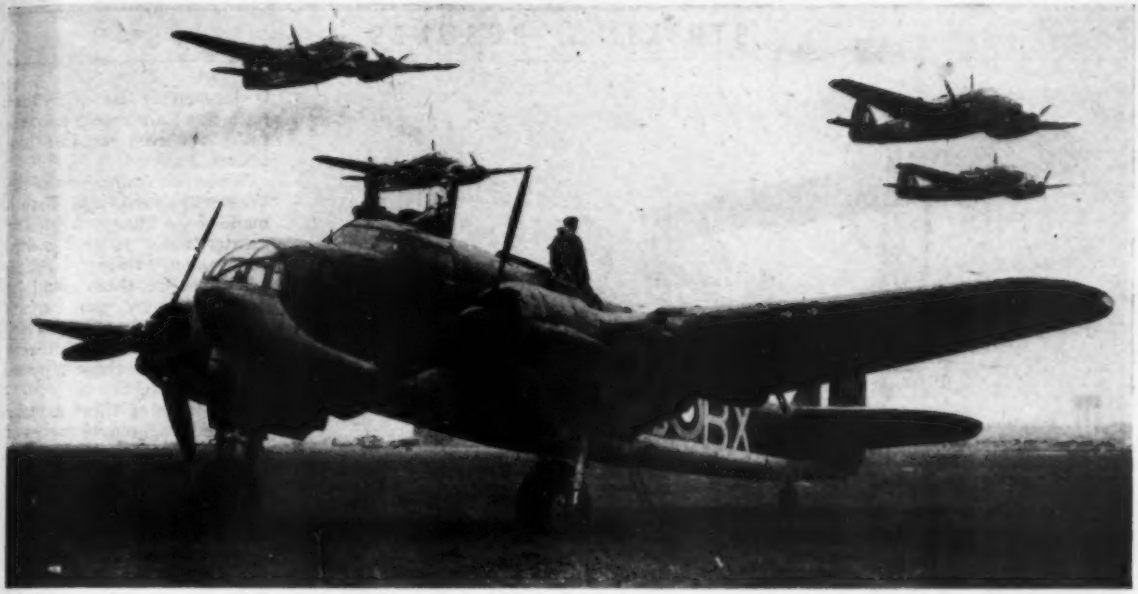
In specially equipped ground laboratories these negative effects of high altitudes on the human body and aircraft equipment are being carefully studied. And it is these constant researches and experiments which have largely succeeded in eliminating the difficulties and in creating a variety of new equipment made to withstand the peculiar conditions of high-altitude flight.

Protection for "George"

"GEORGE" is, as most readers of *Flight* will know, the nickname given to the automatic pilot which on long flights relieves the pilot of the need to control the aircraft, so that he can devote his time to other duties, or take a brief rest if circumstances permit. The apparatus was, as our readers may remember, the invention of two technicians, Mr. F. W. Meredith and Mr. P. A. Cooke, while they were employed at the Royal Aircraft Establishment. The manufacturing rights were secured by Smith's Instruments many years ago, and both inventors have left the R.A.E., Mr. Meredith to join Smith's and Mr. Cooke to take charge of instrument and much other equipment at M.A.P.

The normal life of a patent is 16 years, and an invention must be of very great merit to secure a prolongation of the patents, even for a period of five years. Recently a petition was made to the Courts, asking that the patent rights of the automatic pilot (there are four in all) might be extended beyond their normal term. The petition came up for hearing on May 18th and 19th, and, after evidence had been given on behalf of the petitioners, the Court decided that the invention was of sufficient merit to warrant the granting of prolongation, not only for the five years usual in such cases, but for a period of eight years.

It might be pointed out that in the history of patents there are very few cases in which prolongation of patents has been granted for more than five years, so that it will be realised that quite exceptional merit was attached to the Smith's Automatic Pilot.



A formation of Bristol Beauforts returning from a North Sea attack. The Beaufort is the standard torpedo-bomber of Coastal Command.

STRIKING RESULTS

Value of Torpedo Aircraft Not Fully Realised : What the Sinking of a Tanker Means : Should the Navy Have Air Control of Merchant Shipping Routes?

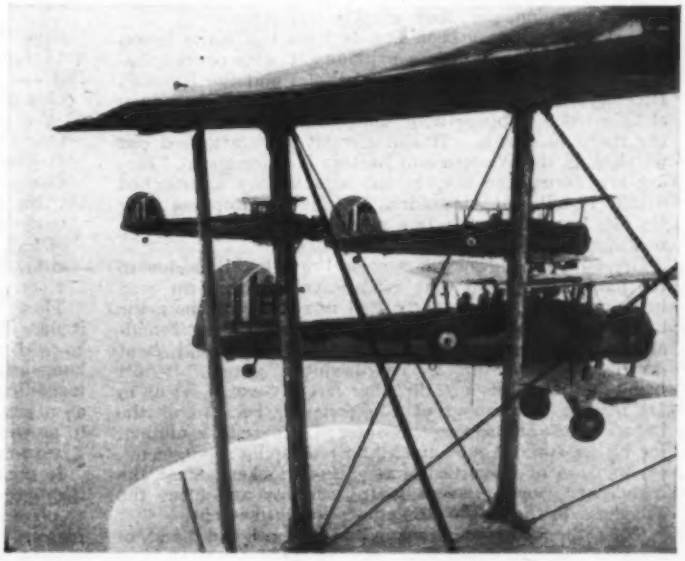
By "FOUGUEUX"

WITH the possible exception of German paratroops, who raised surprise attack to a formal evolution, it may be confidently claimed that of all the forces in the war to date that which has returned the richest dividend is the torpedo striking force of the Fleet Air Arm.

Each month the toll of the torpedo launched from aircraft mounts formidably. The graph of crippling blows against enemy forces is constant in its upward tendency. Along its aggressive path stand brilliant actions which mark turning points as the battle swings from one war zone to another.

Few can doubt that the assaults on Malta were aimed at neutralising that base from which torpedo aircraft have so continuously launched attacks against Tripolitanian convoys. The worst barb in that thorn which is Malta is the torpedo aircraft, the elimination of which would put the Western Desert campaign in an entirely different light.

The collective account of the F.A.A. torpedo aircraft force which, though growing, can only be regarded as small in comparison with the legions of the R.A.F., makes impressive reading. Undertones in the death rattle of the *Bismarck* were the sounds of attacking Swordfish. Sensational victories against Italian sea power at Taranto and Matapan showed how dangerous a puny force of torpedo aircraft could be. Vichy Syria learned the measure of sea control which scanty T/A forces could exercise against cruisers and destroyers in the Levant. When enemy convoys sheltered in Valona Harbour, or ventured under heavy escort to Tripoli and Benghazi, or slunk stealthily up the Norway coast or along the Frisian littoral, there and then the sting of the torpedo aircraft has left its mark—its fatal mark.



Fairey Swordfishes in full warpaint over the Mediterranean. The Swordfish has been the carrier-borne torpedo of the Fleet Air Arm for a number of years.

D

STRIKING RESULTS

The Fairey Albacore is a modern torpedo-carrying biplane. A wing-folding arrangement enables it to be accommodated on a carrier's lift.

Analysis of attack results over a long period indicates that the torpedo appears to have an immeasurably greater degree of success than the bomber. These statistics, like all others, may have a misleading air, since the scale of air torpedo attack has not been nearly so great as the bomb attack; if the success has been higher, the opportunities for failure have not been so frequent. Nevertheless, a torpedo hit is mostly fatal, whilst only a low percentage of bombs can be likewise regarded. This would appear to have an important bearing on our future policy; it would, for instance, be revolutionary to have a large aircraft carrying, say, four or more torpedoes.

Nor has the enemy been slow to learn this major lesson of the war. The Japanese exploited it with overwhelming success against the *Prince of Wales* and the *Repulse*. Recently, German land-based torpedo aircraft types have attacked our shipping with some success off Norway on the route to Russia. Italian aircraft have attacked our warships in the Western and Eastern Mediterranean. Flying low across the sea, in one attack they approached within 25 miles of Alexandria, fortunately dropping their tin fish far outside effective range before scudding away to distant safety.

Great as its widespread success has been, it is due to the pioneers to recall that not always has this arm been in favour. Gunnery experts used to ridicule claims made by the advocates of the torpedo aircraft as a most formidable striking weapon. They calculated they could shoot down slow-flying aircraft as absolute "sitters," whilst being sure that the use of faster aircraft would result in (1) inaccurate running of the torpedo, because of the impact shock on meeting the water; (2) inaccurate aiming, for higher speed would much affect the pilot's judgment; (3) increase of casualties among the attackers, since the high speed would prevent swift turnaway and bring the attackers on top of the ship's pom-pom armament.

With the courage of conviction the original band of torpedo aircraft experts maintained that their striking force, even if it faced loss, would be of all-important value: (a) for crippling the enemy at sea; and (b) for attacking the enemy in harbour if he refused to come to sea. It is interesting to note that both these aims were successfully achieved against the Italian Navy.

When the campaigns in the Western Desert and Greece made some transport ships of greater value to the enemy than even their escorting warships (for these could be dealt with by our surface craft in good time) then Fleet Air Arm torpedo aircraft were sent to prevent those supplies getting through.

The tally of these attacks must now aggregate scores of ships. For example, one F.A.A. squadron in the Eastern Mediterranean sank six ships in seven days. Each time an enemy target has presented itself, attack has been made so that it has been the exception for any enemy convoy, or ship to reach Rommel's forces. Let a small enemy convoy venture off the coast, and off will go a torpedo aircraft attack as soon as range permits.

Little impression is made on public opinion when it is announced that our naval aircraft have sunk a tanker or two in convoy, but the fact is that these successes are of the highest consequence.

To take an example, in the closing days of last year Fleet Air Arm aircraft attacked an Italian convoy with the result that one 8,000-ton tanker and one 5,000-ton tanker were sunk immediately, and another tanker of 5,000 tons left ablaze from stem to stern. A total loss of 18,000 tons of tanker shipping of vital importance to Rommel's forces.

Expressed in Gallons

Now this does not sound much at first sight, for it is not commonly realised what this means in converted terms. But:—

One gallon of 87 octane fuel weighs 7.3 lb.

At this rate:—

One 2,000-gallon tanker has about 6½ tons of fuel.

It would be fair presumption that

One 5,000-ton ship might carry 3,000 tons of fuel.

On this basis, to sink one 5,000-ton tanker is equivalent to depriving the enemy at once of at least 920,000 gallons of fuel, sufficient to fill about 450 field mobile tankers for aircraft and tanks, each of 2,000 gallons of fuel—or 2,000 of the 450-gallon variety.

These are striking figures. For purposes of comparison, it may be noted that if our aircraft were to locate, say, 20 field fuel tankers of 450-gallons apiece, and by pressing home attack were to destroy each of those field tankers and its contents, then such an attack would rightly be regarded as a success—yet it would still require 100 such attacks to be equivalent to the sinking of a 5,000-ton ship carrying 3,000 tons of fuel.

In the case of the three-ship tanker convoy quoted above, the figures rapidly tend to become astronomical. Of the 18,000 tons of shipping successfully attacked, it would (for reasons set down below) be a low estimate to claim 11,000 tons of fuel, equivalent to some 3,400,000 gallons.

In terms of flying time this quantity of fuel is seen to be great indeed. Allow a modern 1,000h.p. aircraft engine a cruising consumption of 35 gallons an hour, a twin-engined

aircraft 70 gall./hour, and a four-engined bomber 140 gall./hour.

At 35 gallons per hour, 3,400,000 gallons would be good for about 97,000 flying hours. If we took three hours as a fair average for a flight, the total of fuel destroyed in the tankers converts to:—

32,000 sorties by single-engined aircraft;
16,000 sorties by twin-engined aircraft;
8,000 sorties by four-engined aircraft.

Nor is that all, for had those tankers not been sunk they might have carried further fuel, so that their net immediate loss ought not to mask the fact that all their potential future weight in the enemy's war effort has gone, too.

These figures record the reverse of any tendency to exaggerate the importance of attacks by air against enemy surface craft, especially tankers. The reports of enemy sinkings are given in terms of gross tonnage, a term which might easily be misinterpreted, because the word "gross" gives the impression that the maximum claim possible is being made.

Fitting an 18-inch torpedo to the crutch of a Beaufort. The lower half of the torpedo is painted to harmonise with the underside of the machine because it is not entirely enclosed.

Shipping tonnage is registered in four categories. Gross tonnage is the sum of all the enclosed spaces in a ship measured in cubic feet and divided by 100. Net tonnage is gross tonnage less certain spaces in the engine-room, ballast wells, and so on, which may be regarded as dead or wasted unavoidably.

Carrying Capacity

The deadweight tonnage (abbr. dwt.) is the *carrying capacity in tons* of the ship when loaded to load-waterline. The displacement tonnage is the number of tons of sea water displaced when the vessel is loaded to load-waterline.

How this works out in practice can be seen from the following example from a standard reference work. It will be noted that the carrying capacity of a ship can far exceed its gross tonnage, and yet (since the ship might at the time be empty) it is on the gross tonnage that the success claim is made in official communiqués. The ship is the tanker *Athelduchess*, recorded as:—Tonnage: 8,900 G., 5,200 N., 13,100 dwt.

In other words, if our air striking forces claimed to have sunk a ship of 8,900 tons, that vessel might be carrying 13,100 tons of fuel. It will be clearly seen, then, that in the examples given above the assessment of 11,000 tons of fuel for 18,000 tons of shipping may be a severe under-estimate; it is not outside the bounds of possibility, in view of the urgency for fuel to the Axis forces, that the figures estimated for that three-ship tanker convoy's cargo should be multiplied by three.

The obvious implication must be that one of the ways in which we can settle Japan is by torpedo aircraft coverage of the South China and associated seas. Expansion of our T/A force on a major scale would threaten the very arteries of Jap conquests, freeing our overworked surface craft (the gallant corvettes, sloops, trawlers and old destroyers) for the essential work elsewhere of defence of convoys against submarine attack. And if that implication is accepted the heir to such a policy would be air control by the Navy of the merchant shipping routes of the world.

ALLIED AND AXIS TORPEDO AIRCRAFT

Main Data of 18 Types

Bristol Beaufort

Span	57ft. 10in.	Maximum speed	About 300 m.p.h.
Length	44ft. 2in.	Engines	Two 1,065 h.p. Bristol Taurus or two 1,050 h.p. Pratt & Whitney Twin Wasp.
Height	14ft. 5in.		
	Range		Over 1,900 miles.

Fairey Albacore

	Landplane	*Seaplane*
Span	50ft. 0in.	50ft. 0in.
Length	39ft. 10in.	42ft. 5½in.
Height	14ft. 2in.	17ft. 9in.
Engine	1,065 h.p. Bristol Taurus	1,065 h.p. Bristol Taurus

Fairey Swordfish

	Landplane	*Seaplane*
Span	45ft. 6in.	45ft. 6in.
Length	36ft. 4in.	40ft. 11in.
Height	12ft. 10in.	14ft. 7in.
Engine	775 h.p. Bristol Pegasus III. M3	775 h.p. Bristol Pegasus III. M.3

Performance and Weights (Landplane only)

Maximum speed	154 m.p.h.	Empty weight	4,195 lb.
Cruising speed	131 m.p.h.	Loaded weight	7,720 lb.
Duration	5–7 hr.	Useful load	1,900 lb.
		Service ceiling	19,250ft.

TORPEDO AIRCRAFT

Douglas Devastator (TBD-1)

Span ..	41ft. 6in.	Engine ..	Pratt & Whitney Twin Wasp.
Length ..	35ft. 0in.	..	—
Performance ..	No data available.		

Fokker T.S.W.

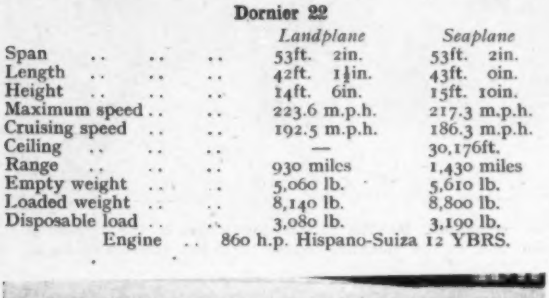
Span ..	65ft. 7in.	Maximum speed	222 m.p.h.
Length	49ft. 10in.	Service ceiling.	22,300ft.
Height .	17ft. 8¼in.	Loaded weight.	14,550 lb.
Engines.	Two 890 h.p. Bristol Mercury XI.	Disposable load	4,574 lb.

Latecoere 293

Span	50ft. 10in.	Maximum speed	186.3 m.p.h.
Length	41ft. 2in.	Cruising speed .	167.6 m.p.h.
Height	17ft. 0in.	Ceiling	19,680ft.
Empty weight ..	5,874 lb.	Range	930 miles.
Loaded weight .	9,900 lb.	Engine ..	880 h.p. Hispano-Suiza 12 YCRS.
Disposable load	4,026 lb.		

Dornier 22

	Landplane	*Seaplane*
Span	53ft. 2in.	53ft. 2in.
Length	42ft. 1¼in.	43ft. 0in.
Height	14ft. 6in.	15ft. 10in.
Maximum speed	223.6 m.p.h.	217.3 m.p.h.
Cruising speed	192.5 m.p.h.	186.3 m.p.h.
Ceiling	—	30,176ft.
Range	930 miles	1,430 miles
Empty weight .. .	5,060 lb.	5,610 lb.
Loaded weight .. .	8,140 lb.	8,800 lb.
Disposable load	3,080 lb.	3,190 lb.
Engine ..	860 h.p. Hispano-Suiza 12 YBRS.	



The Heinkel He 115 is the descendant of a long line of seaplanes produced by Dr. Ernst Heinkel. Even during the war 1914-18 he specialised on twin-float seaplanes at his Warnemuende factory 7 miles north of Rostock.

Heinkel 115

Span	72ft. 10in.	Ceiling	21,320ft.
Length	56ft. 9in.	Range	1,305 miles
Maximum speed	220 m.p.h.	Empty weight ..	11,670 lb.
Cruising speed ..	186 m.p.h.	Loaded weight ..	20,020 lb.
Engines ..	Two 850 h.p. B.M.W. 132DC.	Military load ..	1,947 lb.

Heinkel III K. Mk. V

Span	74ft. 3in.	Range	2,140 miles
Length	54ft. 6in.	Overload range ..	2,640 miles
Height	13ft. 9in.	Empty weight ..	14,400 lb.
Maximum speed	274 m.p.h.	Loaded weight (normal) ..	25,000 lb.
Cruising speed ..	230 m.p.h.	Maximum permissible weight ..	27,400 lb.
Ceiling	24,100ft.	Disposable load ..	10,600 lb.
Engines ..	Two 1,200 h.p. Junkers Jumo 211D.		

Arado 95

	Landplane	*Seaplane*
Span	41ft. 0in.	41ft. 0in.
Length	35ft. 5in.	36ft. 5in.
Height	17ft. 0in.	17ft. 0in.
Maximum speed ..	191.2 m.p.h.	187.5 m.p.h.
Ceiling	26,240ft.	23,945ft.
Empty weight	4,917 lb.	5,588 lb.
Loaded weight	7,260 lb.	8,074 lb.
Disposable load	—	2,486 lb.
Engine ..	880 h.p. B.M.W. 132 DC.	

Fieseler 167

Span	44ft. 3¼in.	Empty weight ..	6,170 lb.
Length	37ft. 5in.	Loaded weight ..	9,920 lb.
Maximum speed	202 m.p.h.	Ceiling	26,900ft.
Engine ..	Daimler-Benz DB. 601B.	Range	930 miles

CANT 506B

Span	86ft. 11in.	Ceiling	27,880ft.
Length	62ft. 0in.	Range	1,240 miles
Height	22ft. 2¼in.	Empty weight ..	18,040 lb.
Maximum speed	229 m.p.h.	Loaded weight ..	26,860 lb.
Maximum speed at sea level ..	195 m.p.h.	Engines ..	Three 770 h.p. Alfa-Romeo 126 RC.34

The CANT 506 follows the typical Italian three-engined formula.

Fiat B.R.20

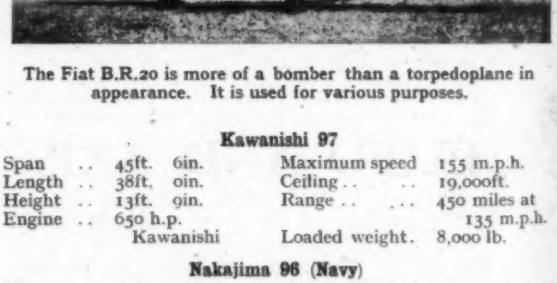
Span	70ft. 6in.	Ceiling	29,520ft.
Length	52ft. 10in.	Ceiling (after bombs dropped)	36,080ft.
Height	14ft. 1in.	Empty weight ..	14,300 lb.
Maximum speed	268 m.p.h.	Loaded weight ..	22,220 lb.
Maximum speed at sea level ..	232.8 m.p.h.	Range	1,863 miles
Engines ..	Two 1,000 h.p. Fiat A.80 RC.41.		

Savoia Marchetti 94

Span	69ft. 9in.	Maximum speed	260 m.p.h.
Length	58ft. 9in.	Engines ..	Three 750 h.p. Alfa-Romeo 126 RC.34

Caproni 312 L.S.

Maximum speed	236 m.p.h.	Ceiling ..	16,400ft.
Range	373 miles	Engines ..	Two 650 h.p. Piaggio P.XVI



The Fiat B.R.20 is more of a bomber than a torpedoplane in appearance. It is used for various purposes.

Kawanishi 97

Span ..	45ft. 6in.	Maximum speed	155 m.p.h.
Length ..	38ft. 0in.	Ceiling	19,000ft.
Height ..	13ft. 9in.	Range	450 miles at 135 m.p.h.
Engine ..	650 h.p. Kawanishi	Loaded weight.	8,000 lb.

Nakajima 96 (Navy)

Span ..	49ft. 0in.	Maximum speed	168 m.p.h.
Length ..	33ft. 0in.	Cruising speed .	145 m.p.h.
Height ..	14ft. 9in.	Ceiling	20,000ft.
Engine ..	600 h.p. Kotobuki	Range ..	900 miles with 900 lb. bombs and 180 gallons of fuel.
		Normal weight ..	7,300 lb.

Mitsubishi 97

Span	50ft. 9in.	Cruising speed .	167 m.p.h.
Length	33ft. 11in.	Ceiling	23,000ft.
Height	14ft. 2in.	Range	470 miles
Maximum speed	195 m.p.h.	Weight (normal)	8,500 lb.
Engine ..	900 h.p. Kinsei.		

Topics of the Day

EXCRESCENTIAL

"Indicator" Dares to Criticise the Exterior Detail Work of Some Modern Aircraft and Wonders Whether We Are Getting Careless

IN the piping days of peace (who piped, and why?) it used to break our hearts to see beautifully clean aircraft having their appearance and their performance spoilt by the necessary additions of offensive and defensive equipment. How we howled when the beautiful undersides of wings were covered with those awful exterior bomb racks, fitted as a sort of afterthought, and how we screamed when such machines as the original *Britain First*—so nice and smooth and clean—were made into military aircraft and covered with jutting projections in the interests of Mars.

Even during the comparatively early days of the war things were still being "stuck on," as it was found that certain machines were specially vulnerable in certain directions or could be made useful in some way for which they were not originally designed. Now that it is obsolescent though still very useful and somewhat different in its later forms, I suppose there is no harm in mentioning one particular type, the Blenheim. When I originally ferried these machines they were more or less unequipped and extraordinarily fast at quite small boosts. Then I began to move them about the country with their guns and what-not installed; slower and slower. Finally, some of the Blenheims equipped for special duties were almost heart-breaking. If I'd never flown the type in its bare form I should probably have thought that the performance was marvellous, even in its last Christmas-tree form; it was simply that the difference was so painful.

Necessary Appendages

Now, the Blenheim was designed years before the war and before we began to know quite what was wanted in a war machine. If the same type had been jigged and laid out, even in 1940, there would have been fewer excrescences. As it was, the Blenheim turned out to be one of our most useful aircraft, but in order to make it more useful and less vulnerable bits had to be "stuck on," since the production flow could not be stopped while major alterations were made to the general design.

Exactly the same sort of thing happens to nearly every other type in due course, and even some of the offensive or defensive excrescences, on occasion, have to be removed again because the loss of speed is not matched by the usefulness of the new gun or guns. And let us not get all inferiority-complex about it; the Germans have had much greater troubles, since so many more of their first-line machines were designed and put into production before anybody had really discovered the meaning of war.

All of which is merely a preliminary canter. I think that designers are far too careless about minor and apparently incidental excrescences. Or perhaps it would be better to say that our engine designers have been too kind, and have given us so much power to play with that we can afford to be careless. I don't think we *can* afford to be, but that is my own opinion, and I haven't attempted to design a machine without exterior irregularities; probably, if I had, I should now tear all this up.

Racing Lessons

But most of us remember the old civil air racing days when pilots really had to try and do things with the most inadequate power. How cracks and crevices were carefully faired off, and how windscreens and cowlings were altered and altered until quite extraordinary and Rowarth-Dancy-defeating increases in speed were obtained. With anything up to 2,000 h.p. to draw on, such refinements are hardly necessary, but, at the same time, the speeds of previous King's Cup races were comparatively low, and, unless my theory is wrong, cracks and crevices are going to be a good deal more powerful in their effects at higher speeds. Perhaps my theory is all wrong, and at high speeds the air makes a kind of cushion round a wing or fuselage, so that the ups and downs are no longer of any importance. Admittedly, the angles at which the wings join the fuselages and the engine nacelles are far more important than any badly fitting cowlings.

A Bird's Eye View

The other day I stood on the pilot's seat of an obsolescent twin-engined machine of no great merit and surveyed the centre-section and the top of the fuselage. It was neither a pretty nor an encouraging sight, and it explained to me very largely why the performance of this particular machine was never very good. There were things sticking up all over the place. The whole of the top of the centre section—whence, I am told, a great deal of lift was expected—was a mass of nooks and crannies which certainly did not appear in the original blue prints. Covers which didn't cover, fairings which didn't fair, and cowlings which didn't cowl. In two places there was an inch-deep step just aft of the leading-edge, and I wondered what happened to the airflow when it reached that step; there were globular covers, too, which must have played the very devil in the way of flow-breaking.

From previous experience of the differences which can be made to the lift over an entire section of a wing when a cowling or cover comes loose, I should have said that that centre-section did practically no work. In single-seater fighters you only need to have the edge of a gun-cover loose to make that particular wing stall at a speed some 10 m.p.h. higher than usual—with the most outstanding effects on the landing technique. One cannot climb out and tell the beholders *why* you've dropped the machine on one wheel, bounced three or four feet, and come back again on that wheel before darting off the runway in a cloud of dust or mud! Its just one of those things. But the effects are tremendous, apart from one's personal feelings, and that moment of standing, like Cortes, surveying the surface of things, made me wonder whether people really bothered enough, or whether we were going to continue to pile up power in order to get our performance.

By way of postscript and final explanation I shall hark back a few years to the days when our first-line fighter, with an engine, even then, of some 500 h.p., was very little faster than one particular 110 h.p. cabin light plane—and a great deal slower than some of our cleaned-up racing types of the same power. That was because the fighter's whole shape was bad, but I think that the excrescences are at least nearly as important. INDICATOR.

The Steward Served it Hot

THE men of H.M. trawler *Northern Sky*, which formerly belonged to the Grimsby Fishing Fleet, are particularly proud of their success in shooting down a Heinkel last June.

The enemy aircraft came over at 7 o'clock in the morning. Hardly had the alarm finished sounding "Action Stations," when the Heinkel went crashing into the sea a few yards away from them. It had been shot down by the steward manning a machine-gun.

Only a moment before this, steward had been preparing breakfast.

A month later another Heinkel showed too keen an interest in this trawler. It also found trouble, and flew away low over the sea, leaving a trail of smoke.

HERE AND THERE

Under False Colours

FOR the unauthorised display of the R.A.F. roundel on his private motor car, in contravention of the Road Vehicles (Service Marks) Order of 1942, a motorist was at Huddersfield fined £2. The roundel is the well-known red, white and blue target which marks R.A.F. aircraft and vehicles.

Under the Defence Regulations the improper use of such Service marks may be punishable by three months' imprisonment and a fine up to £100.

Flying Feet

NATIONAL SAVINGS STAMPS were the prizes for novelty dances at the "weekly hop" at a R.A.F. station in the Midlands recently.

Air Commandant K. J. Trefusis Forbes, Director of the W.A.A.F., happened to be visiting the station. She attended the dance and presented the prizes, and the winning couples, airmen and their W.A.A.F. partners, each received two shillings' worth of savings stamps.

The R.A.F. and W.A.A.F. personnel serving at this station enthusiastically co-operate in the savings campaign, and have instituted their own National Savings club. Besides their regular savings, their contribution to Warship Week, collected in six days, was more than £3,400.

A.T.C.'s Big Punch

A.T.C. boxers from squadrons all over London and the home counties will be seen in the biggest fights of their careers when the grand finals of the A.T.C. "Silver Wings" tournament takes place on Tuesday, June 16th, at the Albert Hall.

The tournament, promoted by a London newspaper, is the biggest inter-squadron championship so far to be held by the Corps. There will be 16 contests—eight weights in both senior and junior sections. Boxing will be under A.B.A. rules. All the arrangements for the A.T.C. tournament, including referees and timekeepers, will be undertaken by the R.A.F. and the A.T.C. in collaboration with the A.B.A.

It is expected that a number of famous sportsmen, airmen, and other distinguished personalities will be there to see the young pilots and airmen of tomorrow competing for their first "wings."

CLOAKROOM CONFERENCE: An impressive gathering of Allied headgear in the cloakroom of a London hotel during an informal reception attended by members of the U.S. War Mission and Service heads.

Newfoundland Air Link

TRANS-CANADA Air Lines service to Newfoundland, which is being operated as a part of the hemispheric defence plan, is now in operation.

This service links the military outposts of the United Nations in Newfoundland with the mainland by means of a daily round trip between Moncton and St. John's. At the same time, the new service brings the heavy industries of Cape Breton within Canada's national airline network with a stop at Sydney on the tip of Canada's eastern coastline.

Some 400 pounds of air mail were handled on the opening day of the new service, May 1, and of this some 85 pounds originated at U.S. Army bases.

U.S. Output Estimate

ACCORDING to recent reports, J. Carlton Ward, jun., president of the Fairchild Airplane and Engine Corporation, has estimated that the aircraft output of the United Nations is now 8,600 a month, or more than double that of the Axis with a reputed production rate of 4,100 machines a month.

Mr. Ward "breaks down" his total as follows: U.S.A. 3,300, Great Britain 2,400, and Russia 2,900. He thinks that Germany and the occupied countries produce 2,900 aircraft every month, Italy 700 and Japan 590.

Duke Sees Bombers for Russia

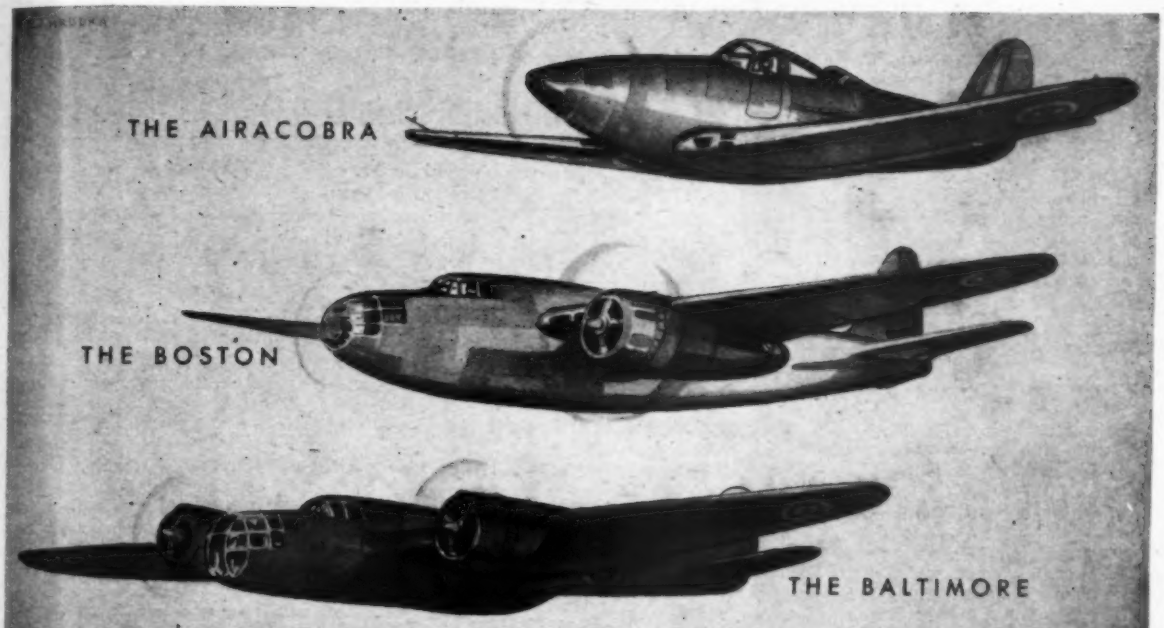
DURING his tour of the Middle East, the Duke of Gloucester had an opportunity of seeing a great deal of British and American aid that is flowing to Russia. At one airfield where his aircraft landed, large numbers of American-built bombers were dispersed.

The Duke displayed great interest in them when he reached the airfield, and was told that they represented only a small part of the bomber fleet that was being flown to Russia day after day.

Later the Duke was shown some of the assembly plants for these aircraft. Many of them in the first instance had been assembled by R.A.F. technicians. Now increasing numbers of American engineers are arriving and taking over the task.

Once they are assembled, the aircraft are handed over to Russian pilots, who fly them away over the wildest mountain country and in all weathers direct to Russia and the Eastern Front.

THE NATIVES ARE FRIENDLY: Men of an R.A.F. West African "outpost of Empire" are obviously popular with the local inhabitants. Reconnaissance bombers, flying boats and fighter squadrons equip the station. This picture was taken at a nearby village.



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A Typical Aerol Strut

THE CLEVELAND PNEUMATIC TOOL CO.

CLEVELAND, OHIO, U. S. A. CABLE ADDRESS "PNEUMATIC"

E

AIRCRAFT TYPES AND HE

Wellington and Hampden Bombers

ONE of the most consistently successful long-range heavy bombers used by the R.A.F., the Vickers-Armstrongs Wellington made its bow, in its original form, in Hendon New Types Park in 1936. But the first production Wellington, which appeared two years later, differed considerably from the prototype and introduced the high aspect-ratio fin and rudder by which the popular "Whimpy" has ever since been easily recognisable.

THIS is the first of a new *Flight* series dealing with current types of Allied and Axis aircraft, which the reader will find useful both to familiarise himself with the many different types and to preserve for future reference.

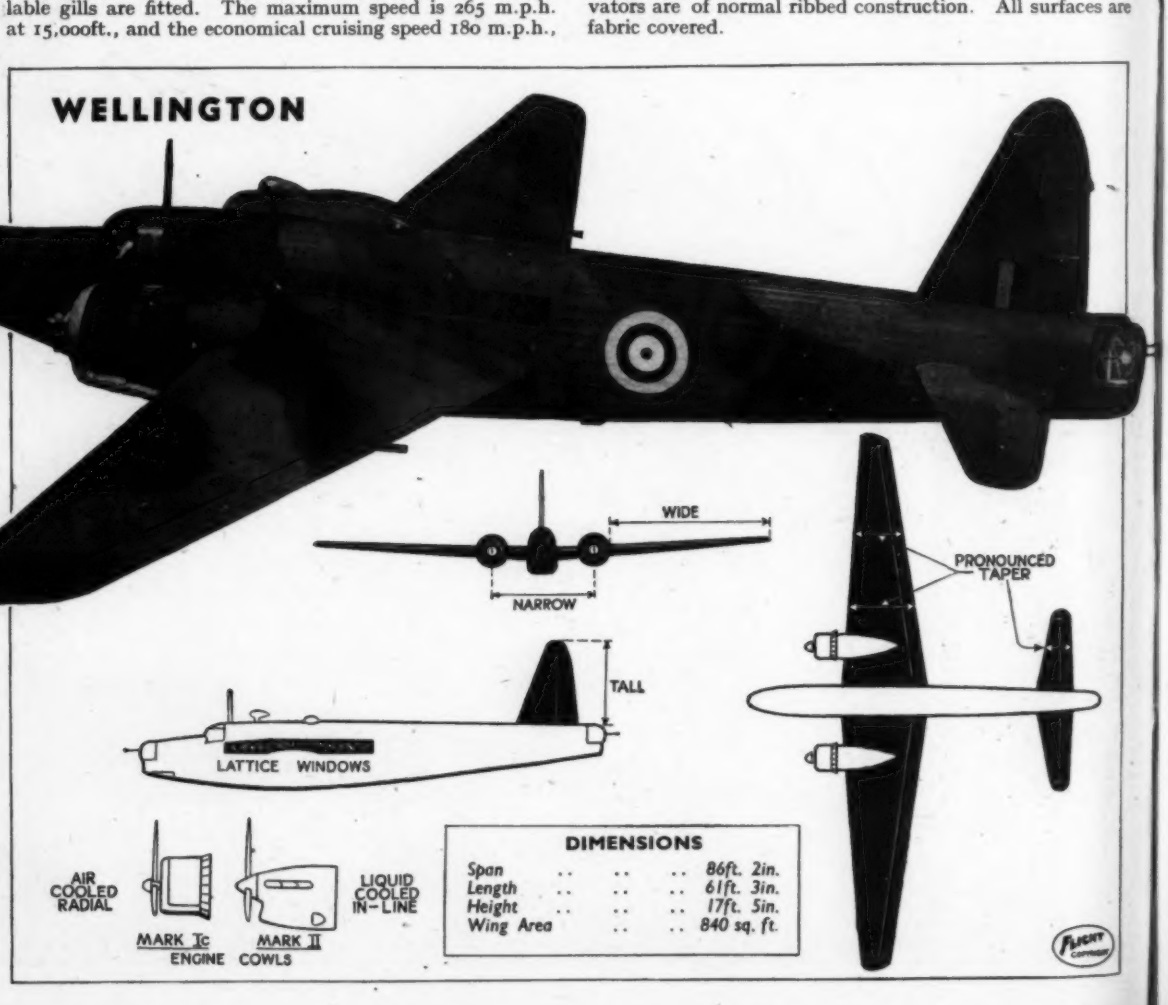
It was about the middle of 1939 when the first squadron received Wellingtons, and subsequent experience in service resulted in the production of the Mk.1a with redesigned gun turrets in nose and tail having greater fire power. This type also had an under-turret, but this was removed on the Mk.1c (illustrated) in favour of two Vickers K guns firing from the cabin windows. This enabled the bomb load and the range to be usefully increased.

Engines fitted to the Wellington 1c are Bristol Pegasus XVIII, which are nine-cylinder, air-cooled radials (geared) fitted with two-speed superchargers and rated at 965 h.p. at 2,375 r.p.m., with 1,000 h.p. for take-off at 2,600 r.p.m. Three-bladed De Havilland c.s. airscrews and N.A.C.A. cowlings with built-in exhaust collector rings and controllable gills are fitted. The maximum speed is 265 m.p.h. at 15,000ft., and the economical cruising speed 180 m.p.h., at which the range is 3,200 miles, and the duration 18 hr. on 1,000 gallons of fuel. Service ceiling is 25,000ft.

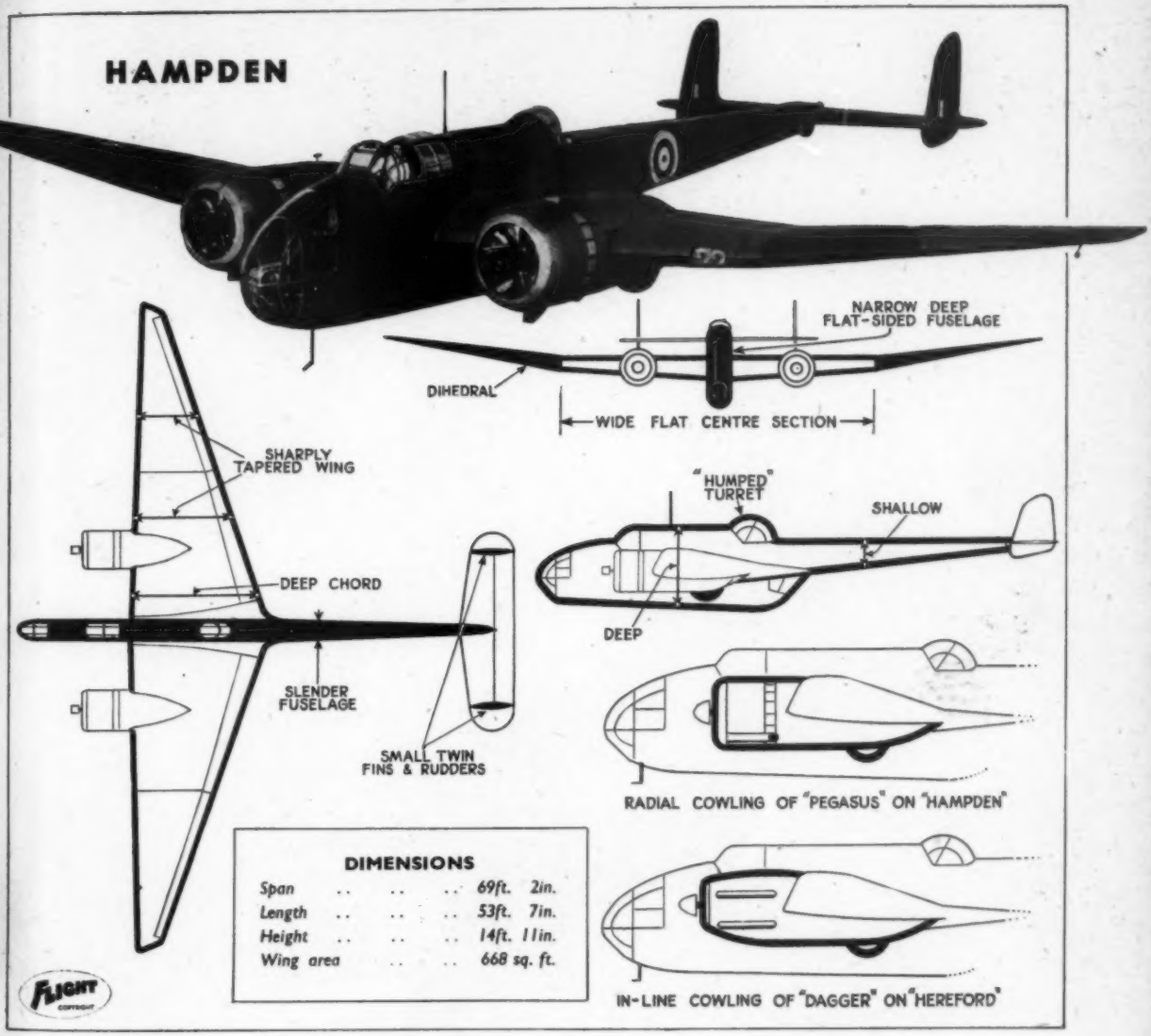
Two other models of the Wellington are also produced, the Mk.11 with Rolls-Royce Merlin X liquid-cooled, 12-cylinder in-line engines of 1,145 h.p., and the Mk.111, with Bristol Hercules 14-cylinder, two-row, sleeve-valve, air-cooled radials of 1,370 h.p. Both these types are similar in other respects to the Mk.1c, but naturally have enhanced performances.

The most notable feature about the Wellington is the Vickers-Wallis method of geodetic construction, which imparts great strength and rigidity with exceptionally low weight, thus securing outstandingly good figures for range and load-carrying. The all-up weight of 28,500 lb. embraces a disposable load of 9,550 lb., which is nearly one-third of the gross figure and includes a 4,500 lb. bomb load.

Another advantage bestowed by the geodetic principle is the absence of bulkheads, frames or ribs, leaving the interior of the fuselage and wings entirely unobstructed and their whole volume available for the accommodation of military equipment, crew, fuel tanks and so forth. Even the fin and tailplane are geodetic, but the rudder and elevators are of normal ribbed construction. All surfaces are fabric covered.



EIR CHARACTERISTICS



DIMENSIONS

Span	*69ft. 2in.*
Length	*53ft. 7in.*
Height	*14ft. 11in.*
Wing area	*668 sq. ft.*

THE Handley Page Hampden medium-heavy bomber is a contemporary of the Wellington, its prototype having appeared (as the H.P.52) in 1936, the production model—with an improved nose—in 1938, and it reached the R.A.F. for actual service the following year. Like the Wellington, the Hampden is now produced with radial or in-line engines, the latter version having Napier Dagger VIII 24-cylinder, H-shaped air-cooled engines of 925 h.p. in place of the Bristol Pegasus XVIII power units. The Dagger-engined type is known as the Hereford and was first delivered to the squadrons in 1940. Except for the engines and a slightly greater span and wing area, the Hereford is similar to the Hampden, but no details of its weights and performance are available.

A mid-wing cantilever monoplane, the Hampden is notable for the boom-like after-part of its fuselage, which is an all-metal monocoque structure with flush-riveted stressed-skin covering. The forward section of the fuselage, which houses a crew of four, is extremely narrow and deep, and has three gun positions, one in the nose (operated by the navigator-bomb-aimer), one above the fuselage over the trailing-edge of the wings, and one below the fuselage at the rear of the bomb bay. It is from here that the section of the fuselage diminishes, tapering to the high aspect-ratio tailplane with twin fins and rudders. The pilot is also provided with one fixed, forward-firing gun placed in the decking of the fuselage.

On early raids certain difficulties were experienced with the armament of the Hampden, and it was, therefore, withdrawn from active service for a short time while the necessary modifications were effected, since when the type has distinguished itself.

The Hampden's top speed is 265 m.p.h. at 15,000ft., and it cruises at 215 m.p.h. at 15,000ft. but its most economical cruising speed at that altitude is 167 m.p.h., when it has a range of 1,725 miles. Its service ceiling is 22,700ft. It has a maximum all-up weight of 21,000 lb., and a service load of 3,587 lb., including crew.

It is a particularly easy machine for the spotter, thanks to its unusual fuselage proportions and its sharply tapered wings with their very deep chord at the roots and small tips. Even the head-on view is strikingly characteristic, with the wide, flat centre section, deep, narrow fuselage and pronounced dihedral well outboard from the engines.

DOUGLAS AIRCRAFT COMPANY, INC., SANTA MONICA, CALIFORNIA, U.S.A.

BEHIND THE LINES

Service and Industrial News from the Inside of Axis and Enemy-occupied Countries

Kawanishi

THIS company, which according to German sources is the largest and most efficient of the Japanese aircraft firms, is reported to be expanded further. Last October the capital of this company was doubled to the amount of 15 million yen.

Output Estimate

ACCORDING to Spanish sources Lt. Colonel Laguet, formerly French Air Attaché in Moscow, is said to have recently stated that the aircraft production of Russia is equal to that of the British Empire, while the production of actual general war materials is greater than that of any belligerent power.

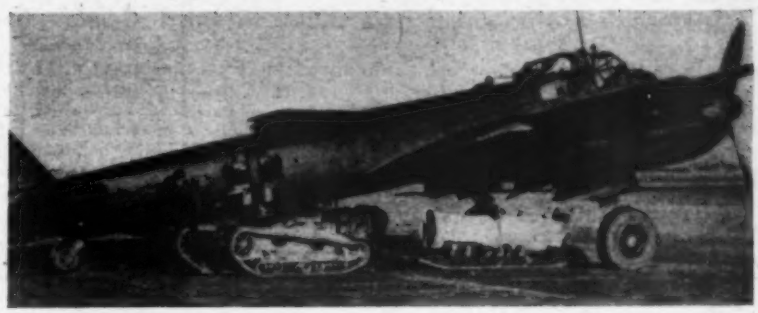
For Air France ?

THE S.N.C.A. du Sud-Ouest has completed the development of a new commercial transport aircraft Bloch 161. The aircraft is powered with four Gnome-Rhone 14 N.38 or 14 N.39 14-cylinder, air-cooled twin-row radials. On a recent test the aircraft was flown to Marseilles-Marignane in unoccupied France, and it is reported that Air France is considering placing an order for thirty machines of this type.

French Fuel

A VICHY sponsored company for the hydrogenation of coal has been registered in Paris. The new "Compagnie Centrale d'Hydrogenation et de Synthese" is to build the first plant at Fuveau (Aix-en-Provence) with a capacity of 25,000 tons benzine and 25,000 tons Methanol. It is proposed to adopt the Fischer-Tropsch process for the production. It appears, however, that the construction of the first plant is being delayed because of the lack of the necessary quantities of high-grade steel.

Lt. Gen. Tomoyaki Yamashita, C.-in-C. Japanese Forces, S.W. Pacific.



TO WHAT AIR BASE USES: A light tank, relegated to the role of airfield tractor, pulling a bomb train. The tank appears to be a French type—probably a captured one.

For the "Luftwaffe"

THE German Press and broadcast announces that a special appeal is being made to pupils of the sixth to eighth forms at German secondary schools to volunteer for training for permanent commissions with the *Luftwaffe*. Applicants born in 1923, 1924 and later, who will register their applications before June 30th, will receive the confirmation of their acceptance before July 1st.

Pupils of the seventh and eighth forms will be called up immediately, and the sixth-formers at some later date.

Field Air Mail

A SQUADRON equipped with Ju 52 machines is to maintain a special service between the Russian front and Germany for the benefit of the German troops. The main task of this communication squadron will be the transport of mail for the troops. This is the first time the German troops in Russia have been given the opportunity of sending and receiving their mail by air. Every soldier and his family are each given two air mail stamps per month.

Since the number of the Ju 52s placed in this service is in no proportion to the requirements of the troops, the issue of these field air mail stamps is to be staggered, and, indeed, the whole service is rather of a symbolic nature.

German A.R.P.

IT seems as if the Germans were lately paying more attention to their A.R.P. problems. . . . Thus on May 29th, the sirens of Berlin were tested.

The Government of the Reich has entrusted the mayors and chairmen of local administrations with the care of the bombed-out and wounded. In co-operation with the local chiefs of civil defence these authorities have been ordered to keep a reserve of housing facilities for the bombed-out.

The District Chief of Police of Hamburg has ordered householders to remove one complete frame with glass from all double windows, and to store it in a cellar as a replacement of broken windows after further air raids. In future no window repairs are to be made without special permission.

All householders are ordered to have their house numbers displayed in phosphorous paint on fences or such other places where they can be seen without the use of a torch.

Denationalisation

THE Vichy Government appears to be adopting a policy of denationalising aircraft firms which were taken over by the State under the Air Minister, Pierre Cot. While in the majority of cases the nationalisation was effected quite smoothly, the new Vichy policy is reversing the process. Recently the "S.N.C. de Moteurs" has been returned to the ownership of the "Société des Moteurs et Automobiles Lorraine."

It is apparently in this way that the Vichy Government expects to remedy the fatal position of the aircraft industry for which nationalisation is blamed, but the cause of which should be sought in a variety of sources.

Junkers Ramifications

THE close collaboration of the Junkers Company with other industrial firms has been recently tightened up. At present this collaboration is demonstrated by a number of changes in the management of the firms concerned.

Thus Dr. S. Rothe, a member of the Board of the Frankfurter Maschinenbau A.G., was appointed to be Managing Director of the Junkers Aircraft and Engine Works at Dessau. The previous Managing Director, Dr. Koppenberg, was entrusted with the control of the German Light Metal Production. It is apparently through his initiative that the Hansa Light Metal Company and the Nordische Aluminium A.G. were formed, which are closely linked up with the Junkers.

But the activities of the new German Light Metal Controller are even wider. He has been instrumental in the recent reorganisation of the Argus Engine Company of Berlin-Reinickendorf. The branch works of the Argus Company at Karlsruhe has been converted to an independent company named the "Süddeutsche Arguswerke, H. Koppenberg," and thus a new link in the ramifications of the Junkers has been created.

THE SWING of the PENDULUM

An American Attempt to Use Non-priority Materials in Aircraft Construction : Spot-welded Mild Steel and Glued Plywood Combination Gives Promising Results

GREAT BRITAIN, and, indeed, all the aircraft manufacturing nations, finished the war 1914-18 with aircraft built mainly of wood. That is to say, all structural compression members were of wood, while the bracing of the biplane wings was of steel wire, and certain fittings and highly stressed parts were also made of metal. But in the main the material was wood.

Somewhere around 1926 the British Air Ministry decided that in future all aircraft ordered for the Royal Air Force were to be of all-metal construction, and manufacturers were faced with the problem of "translating" their aircraft structures into metal. Some had already done so experimentally. For instance, Short Brothers had built the "Silver Streak" biplane entirely of metal in 1919, even to the wing covering. Others had experimented with corrugated steel strip construction, notably Boulton and Paul and the Armstrong-Whitworth concern. The "Silver Streak" was the first metal-clad aircraft built in this country, and thus was well ahead of its time. Its fuselage was of the "stressed-skin" type, although the term had not then been coined. But most designers thought in terms of metal equivalents of their earlier wooden structure members, hence the corrugated strip construction of spars and similar components.

Early Difficulties

The change-over to all-metal construction, which came at a period when the aircraft industry found itself almost bereft of orders from the Air Ministry, and which was dictated by a supposed shortage of the right kinds of timber, was duly effected. For a good many years we had biplanes with metal girder framework and fabric covering, and very good service they gave. More powerful engines resulted in better performance, and the time came when metal covering was obviously desirable. This marked the beginning of what may be termed the "stressed-skin era," which is still flourishing.

Wood construction was not discarded for training aircraft, nor for the smaller civil types, and now the heavy demands made on the metal industry has rendered topical once more the subject of aircraft materials. So-called "improved woods," that is to say, woods the characteristics of which have been changed by compression and by bonding with synthetic resins, have come into use, notably for airscrew blades, and are promising very well. The same principles may, in time, come to be used in the construction of aircraft. But in the meantime a possible intermediate stage seems to have been reached in certain experimental research carried out in America. It makes use of non-priority materials, and merits examination by British aircraft designers.

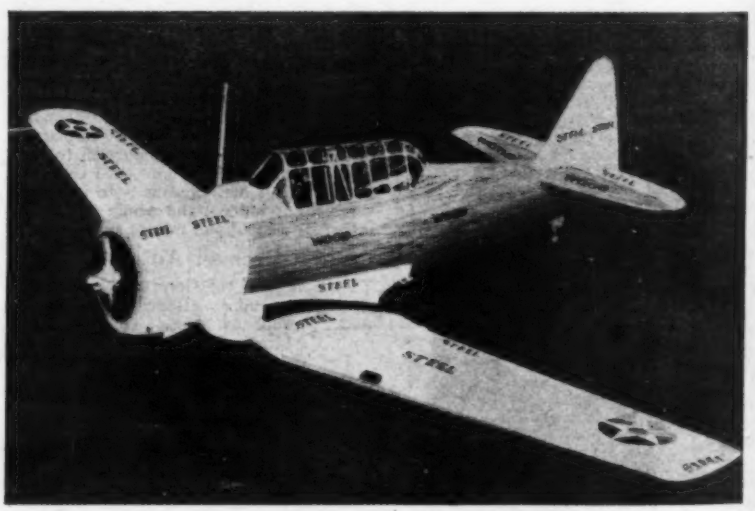
When the United States of America ordered vast numbers of aircraft in 1940, it became possible to tool-up for large-scale production, but it was not long before a bottle-neck was formed by the limited supply of aluminium and its alloys. The engineers of the North American Aviation concern began to look around for alternative materials, particularly wood and steel. High-alloy steels were dismissed from the search because they contained metals in as short supply as aluminium. Mild steel appeared to have possibilities, and was thought to be plentiful. The ordinary type used in motor bodies was discarded on account of its low strength/weight ratio, but an old S.A.E. handbook provided a clue. In this old book of the Society of Automotive Engineers was found a specification, S.A.E.1025, which had a yield point, after heat treatment, of something like twice the yield point of aluminium. A search revealed the fact that the steel company had just sold to a stove manufacturer the last remaining lot of this particular steel. North American did a deal with the stove manufacturer, supplying him with a steel that would suit him just as well in exchange for the S.A.E.1025.

Raising the Yield Point

It was hardly to be expected that the steel would be entirely suitable in its original form, but it served as an excellent basis for research. Ultimately metallurgical research with other steels, and the discovery that cold-rolling of the steel at the mill raised the yield point, resulted in the production of a low-carbon, low-alloy steel having a yield point of 100,000 lb./sq. in. This steel has now been used experimentally for the structure of a North American AT-6A (in service in this country under the name Harvard), and when the necessary tooling-up has been completed, the steel-cum-wood AT-6 will be produced in quantities.

For the time being, the composite AT-6 will be about 150 lb. heavier than the all-aluminium machine, but it is thought that after further research even this slight weight increase may be avoided.

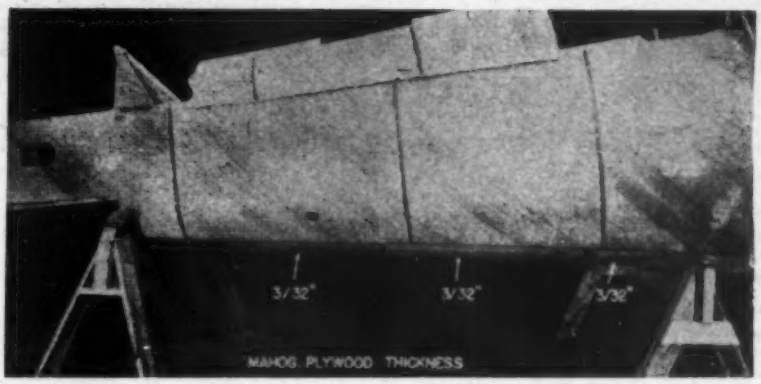
North American engineers point out that the bare structure weight of an aircraft of this type is usually about 25 per cent. of the gross weight. The structure weight increase due to the composite construction was found to be 12 per cent., which is only about 3 per cent. of the Harvard gross weight, or 150 lb. As the machine is stressed for an overload of 350 lb., this increase is well within its capacity, and the effect on performance is probably negli-



In this picture of a North American Harvard AT-6 (Harvard), the artist has indicated the parts which will ultimately be made of mild steel and of plywood. The changes are being introduced by stages. Using materials available at present, the weight will be about 150 lb. greater than that of the standard machine, but it is expected that improvements will get rid of this excess weight.

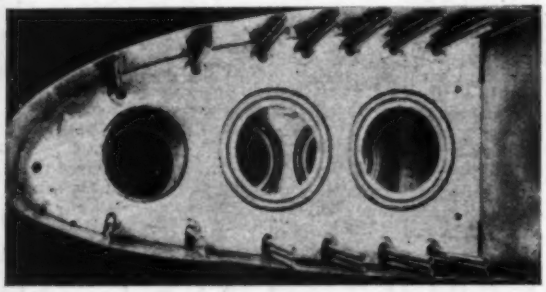
gible; in any case, this is not very important in a trainer.

Reference has been made to the combined use of steel and wood in the experimental AT-6. Generally speaking, steel is used in the entire wing (including control surfaces), while plywood has been applied to the covering of the rear portion of the fuselage. The steel is used in the form of sheet and strip, the thinnest gauge which it has been found practicable to employ being ten thousandths of an inch. Joints are formed by spot-welding, for which the mild steel is very suitable. It has been pointed out that in the standard AT-6 there are no fewer than 52,336 rivets, so that the time saved by spot-welding should be appreciable. For the wing covering, another advantage is that a smooth surface is obtained, better even than that which is achieved by careful flush-riveting.



A Harvard fuselage portion in which the stressed skin covering is of plywood. The thickness varies from $\frac{1}{16}$in. to $\frac{5}{32}$in., and the number of plies from two to seven.

By substituting mild steel and wood wherever possible, it has been estimated that for every 4,000 lb. of normal AT-6 advanced trainer, 1,246 lb. of aluminium is saved. One thousand such trainers would save 623 tons of aluminium, or enough to build 420 fighters or 150 medium bombers. It might be explained that *some* aluminium alloy is still used in the Harvard trainer. About 75 per cent. of that used in the standard machine is, however, saved.



A Harvard wing portion made of mild steel. Joints are made by spot-welding, for which the mild steel is particularly suitable.

From the manufacturing point of view it is claimed that the mild steel sheets need no special protection against corrosion; merely coating them with an oil film suffices for storage and manufacture. After assembly the components are dipped in a wash solution to remove the oil, and then in a weak solution of phosphoric acid for a few minutes. This gives a protective coating of rust-coloured iron phosphate. Even this process may be eliminated. North American engineers are now experimenting with a new compound which can be sprayed on the steel sheet as received from the mill. This compound does not, it is claimed, interfere with spot welding, and if it is found really satisfactory it will avoid the somewhat awkward process of applying a protective coating after the material has been spot-welded into assemblies.

To begin with, North American are not "going the whole hog." But already, in the machines now being produced, the substitution of wooden structure parts for aluminium has resulted in a saving of 185 lb. of aluminium. Later, another 250 lb. of aluminium will be saved by substituting wooden floors and fuselage sections. When the all-steel wing is finally introduced in the production machines, a further 996 pounds of aluminium will be saved.

Wood is used in the form of plywood for rear fuselage covering. Fir, spruce, birch and mahogany are the woods which North American tests have shown to be most suitable. Mahogany will possibly be disappearing from the list, since it is likely to become scarce. The plywood used ranges from two-ply, $\frac{1}{16}$in. thick, to seven-ply, $\frac{5}{32}$in. thick, according to the local stresses to be carried.

So far, North American does not propose to go to the expense and delay of getting in presses sufficiently large to produce large curved panels bonded by resins or resinous glues. They rest content with using casein glues, and for trainer aircraft, at any rate, there is probably no serious objection to this. Casein glue stood us in good stead for very many years. But it seems that ultimately one of the resin processes might be adopted with advantage.

BOEING FORTRESS PRODUCTION DOUBLED

BOEING Flying Fortresses have carried the majority of the burden in the U.S. Army's smashing bomber campaign in the Far East, Colonel John S. Griffith, Army Air Forces resident representative at the Boeing plant, told employees of the company in a special Army Day message.

"Boeing Fortresses are the airplanes credited with the majority of the 62 enemy ships sunk or seriously damaged and the 50 Japanese fighter planes destroyed in the air by the U.S. Bomber Command in the Far East up to March 1, based on reports made public," Colonel Griffith said.

Addressing employees over the public address system, he announced that production of Boeing Fortresses had been doubled since Pearl Harbour. The company's deliveries "have been consistently on or ahead of schedule, and are ahead of schedule at this time," he told them.

Declaring that Boeing had offered to speed up its rate of increase in production even more than it was then doing, Colonel Griffith pointed out that the schedule must be governed by the materials and equipment which it was allotted by the Government. These material schedules, he explained, must be made to cover not only one company but the entire expanding armament programme.

"The Boeing Company is now accelerating at as fast a rate as we are able to obtain materials and equipment for these planes," Griffith said. "Supplies of materials and parts are continually increasing every month and every week. We will get them to you as fast as we can."

Col. Griffith also expressed the American Army's appreciation to the workers for "a magnificent job," and said the Fortresses came off the line ready for combat.

IN PARLIAMENT

Ranks of R.A.F. Press Officers and Their Qualifications : Sitting Up to Hear the Midnight News : Grants to the A.T.C. for Attached R.A.F. Personnel

Public Relations Officers

Wing-Commander Hulbert asked the Secretary of State for Air whether each Royal Air Force command has a public relations officer; whether these posts are held by Royal Air Force officers and of what rank; and what are the necessary qualifications for the post?

Sir A. Sinclair: Public relations officers are attached to each operational Command of the Royal Air Force at home and abroad and to certain non-operational Commands at home. These posts are filled by officers of the Royal Air Force Volunteer Reserve. The senior post in each Command is held by an officer of the rank of squadron leader except in the Middle East and India, where the senior officer is a wing commander. The principal qualification, in addition to the general standard of education required in a candidate for commissioned rank, is a comprehensive knowledge of journalism.

Midnight News Bulletin

Mr. Bossom asked the Minister of Information whether he will consider having the last news bulletin broadcast at 11 p.m. instead of midnight in order to save coal, electricity and gas between 11 p.m. and midnight.

The Parliamentary Secretary to the Ministry of Information (Mr. Thurtle): Hitherto it has not been thought worth while to make such a change in view of the relatively small saving in fuel which would be achieved. But we are asking the B.B.C. to reconsider the suggestion.

Mr. R. C. Morrison: Will the Minister bear in mind the fact that in many families people remain up until 12 o'clock burning light and fuel, just in order to hear the news, and that they would go to bed earlier if the news was at 11 o'clock?

Mr. Thurtle: That consideration will certainly be borne in mind.

Air Training Corps

Major Milner asked the Secretary of State for Air whether he will give particulars of the scheme for the preliminary training of men registered for the Royal Air Force and placed on deferred service; and as to what grants and other provision is being made for Air Training Corps units to which these men are attached?

Sir A. Sinclair: Aircrew candidates on deferred service are put in touch with their local unit of the Air Training Corps. Each unit makes its own arrangements for training them according to local circumstances. The A.T.C. syllabus is used, and it is possible for the men to qualify for the Proficiency Certificates granted in the Air Training Corps and to receive the preferential treatment on entry to the Royal Air Force which these certificates carry. Approval has recently been given to the payment, with effect from February 1st, 1942, of a grant to A.T.C. units of 7s. 6d. in respect of each airman who, during his attachment for training, qualifies for the Proficiency Certificate, Part I. The officer establishment of each unit to which 25 men are attached for training is increased by one and provision is also made for the issue of additional equipment.

Major Milner: While I appreciate the recognition which the Minister has now given to these deferred service units does he appreciate that the grant of 7s. 6d. is very inadequate, having regard to the fact that the Ministry of Pensions pays £1 to A.T.C. units? Why, therefore, may not deferred service units or the A.T.C., to which they are attached, have the same grant?

Sir A. Sinclair: It is considered that 7s. 6d. is the appropriate sum, but if my hon. and gallant friend considers it is inadequate and will let me know of any case, I will certainly look into it.

Sir Herbert Williams: Is the Minister aware that in some cases the people on deferred service are kept hanging about for weeks and months without civil employment?

Sir A. Sinclair: It is to overcome those difficulties that this scheme has been introduced.

ROYAL AIR FORCE FILM PRODUCTION UNIT

Documentary Films Produced at Home and Abroad

WORKING in conjunction with the Crown Film Unit and the Army Film Unit, the R.A.F. Film Production Unit has its established headquarters at Pinewood Studios. The Crown Film Unit—itself a development of the G.P.O. Film Unit—was responsible for such pictures as "The Pilot is Safe," "Ferry Pilot," and "Target for To-night." From now on the Crown Film Unit will concentrate on the civilian war effort and films of the R.A.F., and its auxiliary services will be produced by the R.A.F. Film Production Unit.

The Unit was established in September last with a personnel of sixty. It is at present divided up into a small headquarters section, four mobile shooting detachments in the Home Commands, and a larger mobile shooting detachment for overseas service. This overseas unit is, at the moment, operating in Libya.

The functions of the Film Production Unit are many. A main duty is to make a film record of the work of the R.A.F. in the war—this is extra to the production of documentary films for propaganda purposes. Another phase of their task is to produce training films and films of experimental work which, for security reasons, cannot be entrusted to commercial companies. A small but important side is the supply of special material for commercial productions for which library films are not available and for which facilities to visit stations cannot be granted to commercial companies.

Bristol Beauforts and Lockheed Hudsons have been converted specially to take the cameras. The major modification in each case has been the removal of the rear gun turret and the substitution thereof by a camera mounting.

A Royal Canadian Air Force Film Unit will, in due course, be attached to the R.A.F. Film Production Unit at Pinewood to cover the activities of the Royal Canadian Air Force in this country, and already a small Polish Film Unit is so attached. In general, in addition to making a film record of the Royal Air Force, it is hoped to cover eventually the activities of each Command by a full-length dramatised documentary film of the type of "Squadron 992" and "Target for To-night."

Under the terms of its charter the Unit has a provisional annual production programme of three full-length documentary films and six documentaries each year. "We Search and Strike," a full-length film of the work of Coastal Command, will be released in July.

The following tentative schedule has been embarked upon:—

Home Detachment: "The Big Pack," a feature about the Maintenance Command. "Waterbabies Mark V," a second feature about Waterborne Balloons. "Fly Away Peter," a short about Middle East reinforcements.

Overseas Detachment: The Overseas Detachment proceeded to the Middle East early in this year, and has forwarded some excellent material covering the West African aircraft delivery route; activities of a Sunderland Squadron in West Africa and air shots taken in the Western Desert. Two cameramen from the Detachment were flown to Malta, and the material they obtained during their three weeks' stay is anxiously awaited. It is understood from reports from the Middle East to be excellent.

WORLD PRESS SUMMARY

RÉSUMÉ OF TECHNICAL ARTICLES DEALING WITH AIRCRAFT AND ASSOCIATED SUBJECTS

For the summaries and translations from aircraft and technical journals of the world, we are indebted to the Directorate of Scientific Research and Technical Development, Ministry of Aircraft Production.

Sound Locator

THE device with all accessories including a self-contained power supply, is housed in a case smaller than a gas mask container. Slung over the watcher's shoulder, it enables him to act as an independent mobile aircraft pick-up unit.

In action, the spotter puts on a headpiece consisting of earphones topped by a parabolic "concentrator" of sound waves, from which wires are plugged into an amplifying apparatus in the case.

When a low-pitched sound in the earphones indicates the approach of a plane, the spotter turns his body until the sound is at its loudest. He is then facing the oncoming plane and is able to focus his binoculars swiftly and accurately on the aircraft to be identified.

The device has been approved by technicians of the U.S. Army Signal Corps.

Aural Plane Detector Operated by One Man. (*American Aviation.*)

Fighter Armament

THE British Hurricane and Spitfire fighters are equipped with 4 to 12 machine guns (.303 Browning, firing rate 1,100 rds./min.) and 2 to 4 cannons (20 mm. Hispano-Oerlikon 600 rds./min.).

The German Messerschmitt is provided with 2 machine guns (Rheinmetall-Borsig, .311 cal., 700 rds./min.) and 1 to 2 cannons (either 20 mm. R. Borsig, 500 rds./min., 20 mm. Mauser, 800 rds./min., or 15 mm. Mauser, 900 rds./min.).

The weight of fire per minute is considerably superior for the British machines (viz., 600 lb./min. Hurricane IIc against 240 lb./min. for Me 109F2).

Similarly, superiority is shown if the comparison is restricted to weight of cannon fire only.

The author calls attention to the fact that this comparison leaves out of account possible differences in muzzle velocities of the German and British guns (this would affect accuracy of aim) as well as weight of ammunition supply and reliability of gun feed. As regards the latter, the advantages of a 15 mm. cannon are especially stressed.

Comparison of British and German Fighter Armament. (*Inter Avia.*) (Switzerland.)

Direct Injection

THE author claims that his study of retarded cycles, during which combustion takes place entirely during the expansion stroke, has provided a means for reducing the combustion speed and for increasing the concentration of the air-fuel ratio up to saturation while maintaining a high thermal efficiency. According to him, the combination of a short injection period and retarded cycle will produce the greatest specific power from a diesel engine, while reducing, at the same time, the fatigue of its parts to within acceptable limits.

Researches on a single-cylinder 2-stroke diesel (bore 125mm., stroke 170mm., 8h.p. 800r.p.m., normal rating) have adduced a solution for reducing the fatigue of the diesel engine by permitting the preservation of its components and, at the same time, raising its specific horse-power to par with that of carburettor engines, whilst maintaining for the diesel engine its prerogative of burning heavy fuel under optimum economical conditions.

The feeding of diesel engines by injection pumps actuated by engine compression achieves the required high speeds of injection readily and permits rigorous control of the combustible charge introduced into each cylinder and of the peak pressure in the resultant cycle.

The suppression of the mechanical control of the pumps and the pressure lines simplifies the construction of direct-injection engines and improves their dependability in service.

Direct Injection in Internal Combustion Engines.—(J. E. Tuscher, Pubs. Sci. Tech. du, Minist. de L'Air, No. 89, 1939.) (France.)

Anti-knock Research

FROM a review of published materials the author draws the following conclusions regarding engine knock:

Shock waves emanating from the primary flame front cause the unburnt charge to be heated up above adiabatic compression temperature. At first, however, these waves are damped rapidly and the corresponding temperature rise is slight and uniform. Subsequent waves are, however, sufficiently powerful that their passage initiates a preliminary reaction which at first is flameless, but ultimately gives rise to a secondary flame. This secondary flame is propagated at a higher speed than the primary flame, but the speed is still low compared with true detonation. Further secondary zones of combustion may arise due to the formation of intermediate combustion products of lower ignition temperature (induction period).

The ultimate cause of the knock is thus a shock (detonation) wave. This, however, does not lead directly to the knock, but only serves to initiate a preliminary chemical reaction of the fuel which ultimately leads to the complete combustion of the hitherto unburnt charge by a high-speed "secondary" flame. The author's explanation accounts for two well-established experimental facts: (1) the temperature of the unburnt charge is higher than can be accounted for by ordinary adiabatic compression, and (2) the discontinuity in primary and secondary flame speeds at the instant knock arises.

The Present State of Research on Engine Knock. (F. Dreyhaupt, *ATZ.*) (Germany.)

Fire Power and Armour

THE fire power of the 1939 fighters armed with machine-guns was incomparably greater than that of their predecessors in 1918: double the rate of fire (1,200 against 600 rounds per minute) and six to eight guns against the two originally carried. Moreover, most of the guns are now installed outside the airscrew arc, since modern wing structures are strong enough for this purpose. This enables the highest rate of fire to be utilised and, moreover, removes a possible source of breakdown.

At the outbreak of the present war the British relied entirely upon a large number of machine-guns of about 0.3in. calibre. Most of the French and German aircraft had a smaller number of guns, but included at least one cannon (20 mm.) in their armament. It was evidently felt at the time that one of the heavier weapons was the equivalent of several machine-guns. This conclusion (probably influenced by exaggerated claims made for explosive ammunition based on tests carried out with obsolete types of aircraft structure) was shown to be erroneous. The machine with the greater rate of fire proved to be superior in aerial combat, and plans were made to increase the number of machine-guns still further when the adoption of armour plating by the Germans (autumn, 1940) showed that the machine-gun bullet of 0.3in. calibre was no longer sufficient to produce decisive results.

At the moment we see a race between calibre and strength of armour. Whilst protection against the 0.3 machine-gun is relatively simple, armour capable of withstanding 37 mm. explosive shells presents difficulties. On the other hand, such heavy guns have a low rate of fire and can only carry a limited amount of ammunition.

On account of the difficulty of aim in high-speed combat, the importance of being able to sustain the attack and not run out of ammunition is obvious. At a result a compromise has been adopted by the various air forces. The Spitfire of the R.A.F. is stated to have 20 mm. cannons and four 7 mm. machine-guns, the Italians use 13 mm. machine-guns, whilst the Germans (Me 109F) have two 13 mm. machine-guns (synchronised) and a 15 mm. cannon of a very high rate of fire. The armament of American aircraft appears to be still in a state of flux, and all sorts of combinations of calibre appear to be under investigation.

Aircraft Machine-gun and Aircraft Cannon. (C. Rougeron, *Inter Avia.*) (France.)

THE AIRCRAFT ENGINEER

FLYING BOAT PROJECT

Initial Stages in the Planning of a Design to Fulfil a Given Set of Specification Requirements

By JOHN A. SIZER, A.R.Ae.S.

THE following article, by a writer who has been actively engaged upon flying boat and landplane design since 1929, will, we believe, serve as a very useful introduction to a fascinating subject, particularly for the younger generation in the drawing offices, whose normal work is concerned with details rather than with the general design.

The author is now a technical officer at the R.A.E., but the views expressed are his own.

LET us suppose that we are handed, in our design office, the specification of a required flying-boat design, and that we have to rough-out its general proportions and qualities quickly. This article outlines the procedure adopted before a design is finalised.

1. Specification.—We will say that the specification to be worked to is as here written.

(*a*) All-up weight not more than 10,000 lb.
(*b*) To avoid complication no slats or flaps to be fitted.
(*c*) Alighting speed not to exceed 60 m.p.h.
(*d*) Crew to consist of pilot, observer, wireless operator, engineer.
(*e*) Top speed not less than 150 m.p.h. at sea level.
(*f*) Rate-of-climb at sea level not less than 800-ft./min.
(*g*) Endurance not less than 6 hr. at full load and at 75 per cent. full-throttle.
(*h*) Any engine or engines may be used.

No specification would, of course, read so wide and handsome as the above, but it will serve our purposes here.

2. The Wing.—Wing Loading.—Since no flaps are to be fitted, it will be necessary to restrict the wing loading to a somewhat conservative figure, in order to have a reasonably low alighting speed and take-off. Therefore we will say that the wing loading $\frac{\text{all-up weight}}{\text{wing area}}$ shall be 15 lb./sq. ft.

With a wing loading of 15 lb./sq. ft., the area of wing surface required to support the loaded weight of 10,000 lb. can easily be estimated, thus:

$$\text{Wing Area required} = \frac{10{,}000}{15} = 666.3 \text{ sq. ft., approx.}$$

3. Aspect Ratio.—We now have to choose a wing plan form having a span and chord which will, multiplied together, give us the 666.3 sq. ft. of required wing area. Aspect ratio comes into this because it is a measure of the span divided by the chord; it can also be expressed as squaring the span (in feet) and dividing by the wing area. Here be it noted that a high aspect ratio is aerodynamically a good thing, but structurally uneconomic. In theory, a wing of infinite span is the best. In practice an aspect ratio of 9 is considered daring, and 5 or 6 is the common rule. In some cases even lower figures have been used, but the induced drag has been high unless the wing had a very good plan form, *i.e.* elliptical. We will use the span² method for aspect ratio estimation, choosing a span of 60ft. which should add to aerodynamic refinement.

$\frac{\text{Span}^2}{\text{area}} = \frac{60 \times 60}{666.30} = 5.4$ approx., which seems to be in line with convention. Knowing our aspect ratio, then, we obtain the mean chord by dividing span by A.R.

$$\text{Chord (mean)} \frac{60}{5.4} = 11.1\text{ft. approx.}$$

So now we have the plan form of the wing in units and are able to visualise its size. It is 60ft. in span and 11.1ft. in mean chord. We *could* build a wing to that shape, but it would not be very easy on the air nor clean to the eye. Therefore we will consider making it prettier by rounding off the tips nicely, and tapering the wing (*i.e.* sweeping the leading and trailing edges towards one another at the wing tip). A point to be borne in mind here is that a tapered wing has advantages, apart from its lower induced drag (the resistance caused by a wing in producing lift). The principal gain is a marked saving in structural weight on account of air loads tapering off in magnitude towards the wing-tips. The wing having a tapered plan form and thickness can be looked upon as a beam with a graded load, whereas wings of rectangular plan form are structurally heavier on account of being, in effect, beams with more nearly evenly distributed loads upon them. However tapered wings "stall" or lose their lift at the *tips* first, causing wings to "drop" on the stalled side and leading sometimes to vicious tendencies such as spinning. The rectangular plan form wing, however, stalls at the centre-section first, the stall gradually creeping outwards to the wing-tips. This is reasonably safe, as any stall can be overcome, generally without having to fight out a spin.

4. Taper Ratio.—A taper ratio (root chord divided by tip chord) of 2 to 1 seems to be in general use nowadays and has been chosen in this case. So, having a mean chord of, say, 11ft., our wing will have a root chord of 14.67ft. (at the ℄ of the aircraft) and a tip chord of 7.335ft. By rounding off the tips slightly we shall lose a small amount of wing area, and shall probably end up with something like 650 sq. ft., which is used throughout the text.

5, Wing Section.—At one time there were so few wing sections from which to choose that reliable choice was fairly easy. Data have since been published of literally hundreds of wing sections and consequently the choice is complicated by the variety.

However, for our projected design we will consolidate Anglo-American unity by choosing one of the N.A.C.A. 23000 patterns. A thickness/chord ratio of 15 per cent. will be used at the root and 10 per cent. at the tip ribs. Our wing sections will therefore be:

Root—N.A.C.A., 23015. Tip—N.A.C.A., 23010.

To digress for a moment, it might be helpful to explain that the figures 23015 in the N.A.C.A. nomenclature each have some significance in identifying the wing section. In this manner—

The "2"—indicates the camber of the chord line, as a percentage of the chord.
The "30"—defines, as a percentage of the chord, the position, back from the leading edge of the section, of the maximum thickness ordinates.
The "15"—defines the thickness/chord ratio as a percentage.

From the above definition, therefore, it is possible for us to visualise the shape and size of things at both root and tip of our wing. Since the root chord is 14.67ft., the maximum depth of the section will be $\frac{14.67 \times 15}{100}$ft. = 2.2ft., approx. And this maximum thickness will be 30 per cent., *i.e.* 4.4ft., back from the leading edge of the wing root rib. For the tip we have $\frac{7.335 \times 10}{100} = 0.74$ft. for the maximum thickness, and the position of this depth is 1.48ft. from the tip rib leading edge.

The contour of the wing ribs in between these two sections will be obtained at a later and more finalised stage in the design, from a wing ordinograph specially prepared, or by the more lengthy and questionably accurate method of layout to as large a scale as paper sizes and office space will allow.

For the moment, having an idea of the wing size and

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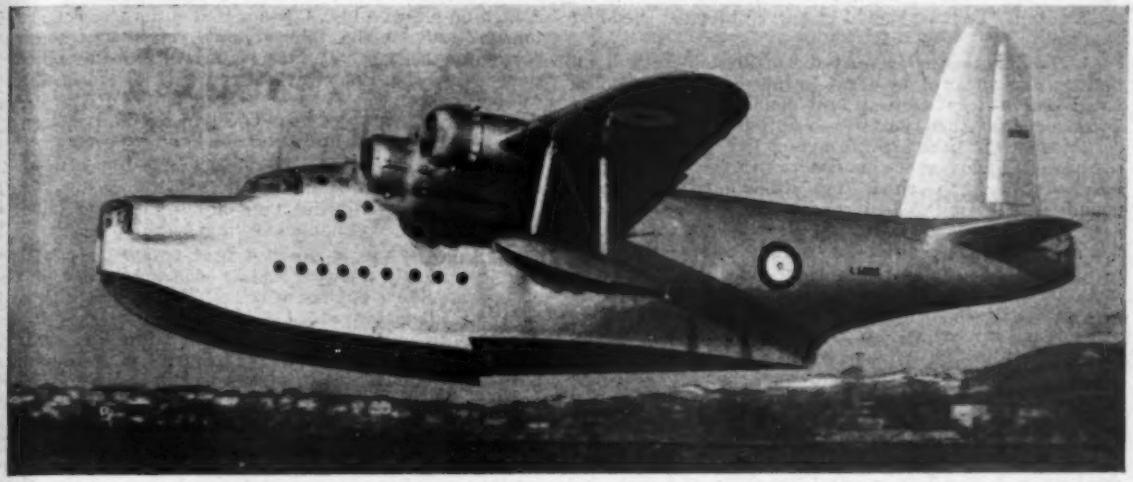

Many of the features of design dealt with in this article are shown in this picture of a Short Sunderland flying boat, although it is a much larger machine than that dealt with in the text.

shape, we will leave it, and pass on to a rapid estimation of the hull characteristics, because we cannot consider the location of the engine or engines and their relationship to the wing until we have some idea of the hull proportions.

6. The Hull.—The beam can be arrived at with sufficient accuracy for our purposes of project work by using the method of beam coefficients given in N.A.C.A. Technical note No. 464. Thus :—

$$C_{\Delta} = \frac{W}{63.4 \times b^3}$$

in which C_{Δ} is the beam coefficient, W the loaded weight in lb., and b the beam in feet. C_{Δ} is said to vary between 0.35 and 0.50. However, I have made an analysis of British hulls of up to 10,000 lb. all-up weight, and C_{Δ} appears to be much higher. For instance, at a loaded weight of 9,500 lb. the Saro "Cloud" shows C_{Δ} to be 0.79. For British hulls C_{Δ} would appear to range from 0.35 to 0.80, the lower figure for heavier machines. The American hulls show a wider beam and consequently lower beam loading, thereby attaining lower values of C_{Δ} which will probably reflect in enhanced water performance at the expense of greater air drag.

In the case of our projected design a beam coefficient of $C_{\Delta} = 0.73$ will be used. This gives a beam of 6ft., which would seem reasonable.

7. Steps.—Established practice seems to be that hulls for flying boats *below* 5,000 lb. all-up weight have satisfactory water performance with a single-step hull. Above that all-up weight and right up to machines the size of the mighty Martin "Mars" (140,000 lb.) two steps in the planing bottom seem satisfactory. Therefore we will have a two-step hull. The depth of the main step should be between 6 per cent. and 10 per cent. of the beam, in inches, depending upon the power loading of the flying boat and the efficiency of the hull planing bottom. The *lower* the power loading and the more efficient the planing bottom or hull form the less depth is required at the main step. Our power loading is fairly normal, so if we make the step 4in. in depth we should be on the safe side.

It may seem superfluous to point out that steps are provided in order to break down water suction during take-off. If they were not there, the boat would not become airborne.

The plan form of the step varies in different designs. Some are straight athwartships, some are in the shape of a vee with the apex aft, at the keel. Despite the claims of both schools, there are snags and advantages in both schemes. We will not go into them here, but decide to use the straight un-vee'd step, because it makes for easier construction.

The second step should terminate in a faired vertical knife-edge.

8. Main Step/C.G. Relationship.—The heel of the main step at the keel should be in such a position that a line drawn through it and the C.G. of the aircraft should make an angle of some 2 deg. to 3 deg. forward of a vertical drawn through the main step heel. The position of the main step will be verified by subsequent tank tests, but hull design, and flying-boat design in general, has progressed to the stage when fairly accurate predictions can be made without resort to tank work, in the first instance.

9. Hull. Profile/Forebody Length.—This is the distance from the stem to the main step and is usually 2.7 times the beam in feet. Thus, in our layout, the forebody length will be $2.7 \times 6 = 16.2$ft.

10. Distance Between Steps.—The distance between steps, that is, the distance between the main step and the aft step, should be about 0.78 of the forebody length, which will be, for our design, $16.2 \times 0.78 = 12.64$ft.

11. Hull Length.—We have established stem to main step distance and main step to rear step distance. The overall length of the hull should consist of roughly the above-mentioned distances plus main step to rear step distance. Therefore the total hull length is 41.48ft.

12. General Outline.—Having decided the above points, the remainder of the hull profile can be laid down. The shape of the keel line in profile, forward of the main step, should be thus : For a distance equal to the beam $\times$ 0.60 the keel should be horizontal. It should then rise in a gentle curve to meet and fair into the stem, which should be well clear (0.50 of the beam) of the loaded water line. The planing bottom, in order to keep the forward part of the hull as dry as possible when running, should be flared gradually towards the stem. Aft of the main step the keel line should rise at some 7 deg. until the rear step is reached. At the rear step the planing bottom should be faired into a vertical knife-edge, and merge into the hull tail. The tail of the hull should rise so that it is clear (reasonably) of shipping green water when the boat rotates about the main step during the unstick run. The deck line should slope slightly down from the cockpit to the stem to give the pilot the best view forward. Aft of the main plane trailing edge the decking should be straight, with a slope down to

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the hull tail. Decking should be curved to assist shedding of spray.

13. Hull Cross-section.—At the main step we will fix the deadrise angle of 15 deg. In this matter it should be noted that a deep vee-sectioned planing bottom gives a lower air drag than flatter vee-sections, but the water performance can be seriously impaired if the angle of deadrise exceeds 25 deg. at the main step. Hollow-vee sections, which until quite recently were widely used, and which definitely make for cleaner running, have now been discarded on account of their high air drag. Assuming the use of 7ft. diameter airscrews, we can estimate the hull depth, bearing in mind that a deep hull—within limits—is a good feature. The airscrews should have at least 3ft. clearance between their tips and the water. To be on the safe side this will be made 4ft., and this distance plus 3ft. 6in. (airscrew radius) is 7ft. 6in.—say 8ft. Assuming the thrust line to be in line with the top of the root rib (which we know to be 2.2ft. deep), and also deciding to sink the wing into the top of the hull, we have a total hull depth above the load water line of 8ft. — 2.2ft., say 6ft. The height from keel to chine, with 6ft. beam and 15 deg. deadrise, will be 0.81ft., so that the depth of hull at the main step, from keel to lower surface of the wing, will be 6.81ft.

14. Control Surface Areas.—In a trial layout such as ours, it is general to use what are termed " control volumes " to determine the areas of fin, rudder, elevators, and ailerons. These control volumes are arrived at as follows :—

For stabiliser and elevator

$$\frac{S_T + S_E}{S_W} \times \frac{L}{C_E} = 0.40.$$

For elevator

$$\frac{S_E}{S_W} \times \left(\frac{L}{C_E}\right)^2 = 0.45.$$

For fin and rudder

$$\frac{S_F + S_R}{S_W} \times \left(\frac{L}{S}\right)^2 = 0.06.$$

For rudder

$$\frac{S_R}{S_W} \times \left(\frac{L}{s}\right)^2 = 0.04.$$

For ailerons

$$\frac{S_A}{S_W} \times \left(\frac{l}{s}\right)^2 = 0.065.$$

The symbols have the following meaning :

C_E = mean chord (feet).
S_W = wing area.
S_T = area of stabiliser.
S_E = area of elevators.
S_F = area of fin.
S_R = area of rudder.
S_A = area of ailerons.
L = moment arm (for fin, rudder and elevator. The distance back from C.G. to c.l. of control surface hinge).
l = moment arm (for ailerons : from C.P. of ailerons to c.l. of aircraft).
s = semi-span.

The volumes given above have been obtained from an analysis of existing successful flying boats of a similar type. By the use of the above, and without going into detail, our areas will be :

Stabiliser	58 sq. ft.	Tail plane 104 sq. ft.
Elevator	46 sq. ft.	
Rudder	26 sq. ft.	Fin and rudder, 50 sq. ft.
Fin	24 sq. ft.	
Ailerons	24 sq. ft.	

In proportioning these areas on the layout we bear in mind that long narrow surfaces are more efficient than short wide ones—aspect ratio again—but a compromise must be struck to gain economy in structure weight. This is particularly necessary with regard to the fin and rudder. A high fin means a high C.P. for that surface, causing large torsion loads in the thinned-down sections of the tail portion of the hull. The tail plane will probably be 20ft. span with a chord of 5ft. giving an A.R. of 4. Elevators will have a span of 20ft. or so, and a chord of 2.3ft. with an A.R. of 8.70. For control effectiveness and efficiency, large aspect ratios should be used wherever possible.

15. Tail Unit. General.—The fin and rudder, together with the tail plane, should be mounted so as to be well clear of solid water during take-off and alighting and also so that they are reasonably safe from spray buffeting.

16. Engines.—It is assumed that two engines will be used, mounted in the wing leading edge and driving tractor airscrews. These engines will be of 400 h.p. each and turn 7ft. diameter 3-bladed airscrews through gearing. The engines will be air-cooled radials, to minimise piping runs, installation troubles, weight, and also to reduce servicing time. Their fuel consumption, at a rating of 300 h.p., will be taken as 0.50 lb./h.p./hour. If, as stated in our specification, we are to provide for a duration, at cruising speed, of six hours, then fuel to be carried will be $0.50 \times 300 \times 6 = 900$ lb. Taking fuel to weigh 7.5 lb. per gallon (87 octane), the tankage required will be $\frac{900}{7.5} = 120$ galls.

With allowances for starting, taxying, and climbing, this can usefully be increased to 150 galls. The tanks will be in the wing centre section. One oil tank will be installed in each nacelle and will have a capacity of 0.04 lb. × 100 × 2 gallons = 8 galls. It is necessary to boost this up and we should allow for 10 galls. + 2 galls. air space. As far as possible, bearing in mind para. 13, effort should be made to keep the thrust line low, to avoid troubles in engine-on and engine-off flight and to avoid aggravating any porpoising tendencies. It is better, from considerations of air drag, to keep most of the engine-cowling below the wing and have as little as possible on the upper surface.

The engine mountings will project from the front spar of the wing torsion-box in such a way that the vertical c.l. of the airscrews is at least one-quarter of the chord ahead of the wing leading edge.

17. Lateral Stability.—To prevent the boat rolling over sideways on the water, because of its " built-in " instability we have to provide means to aid lateral stability. We will choose, from the five or so possible methods, wing tip floats. They will be placed at 70 per cent. of the semi-span outboard from the hull c.l. Thus : $\frac{30 \times 70}{100} = 21$ft. or 9ft. from each wing-tip. Their volume will be estimated from $R.W\ (h + \sqrt[3]{W})\ \sin\theta$ lb. ft.

where W = all-up weight of boat in lb. (10,000 lb.).
h = negative metacentric height of hull in upright condition in feet (1.6 for our boat).
θ = angle of heel or roll to submerge completely a wing float (7 deg. generally).
R = 1.0 for our example.

Minimum righting moment then for one float

$$= 1.0 \times 10{,}000\ (1.6 \times \sqrt[3]{10{,}000}) \times 0.12187.$$
$$= 10{,}000 + 11.6 \times .12187 = 14{,}137 \text{ lb. ft.}$$

Minimum displacement of one float $= \frac{14{,}137}{21} = 672.5$ lb.

Since sea water weighs 64 lb. per cu. ft., the volume of our wing-tip float will be :

$$\frac{672.5}{64} = 10.5 \text{ cu. ft.}$$

This 10.5 cu. ft. represents the length, breadth, and depth of the float multiplied together. We can also say if we assume a block coefficient of 0.50 that

$0.50 \times (L \times B \times D) = \text{volume} = 10.5\text{ft.}^3$
and $0.50 \times (4B \times B \times B) = 10.5\text{ft.}^3$
$2B^3 = 10.5$

$$B^3 = 5.25$$
$$B = \sqrt[3]{5.25}$$
$$B = 1.74\text{ft.}$$

also $D = 1.74\text{ft.}$

and so $L = 4 \times 1.74\text{ft.}$
$= 7.06\text{ft.}$

It will not be necessary to use a step on our floats as steps are seldom fitted to small designs. The float heel should be upswept to prevent it "digging in" when the boat drifts backwards, and the bows of the float should be raised to ensure getting clear of waves. The decking should be well curved to shed water and spray, and the bottom should, of course, be vee-d, flaring out towards the bows. The float should be set so that when the c.l. of the flying boat is vertical, the float should be clear of the water by about 4in. to minimise roll before restoring moment is applied.

18. Float Attachment.—The simplest form is by means of two struts, one from the front spar and one from the rear, to strong bulkheads in the float. These struts can either be braced or cantilevered. We will choose the cantilever type to reduce drag and the number of bits and pieces.

19. Weight Estimate.—We have now reached the stage when we need a provisional weight estimate. This is necessary in order to check our layout drawing for correct disposition of everything in relation to the centre of pressure of the wing section. Our limiting weight of 10,000 lb. is made up as follows:—

	lb.
Hull, 12% A/U (all-up weight)	1,200
Wing, 20% A/U	2,000
Tail unit, 2.5% A/U	250
Controls, 1.0% A/U	100
Wing tip floats, 1.3% A/U	130
Engine nacelles, 1.6% A/U	160
Marine gear, 2.5% A/U	250
Instruments, 2.0% A/U	200
Wireless	200
Equipment at crew stations	70
Engine equipment: Cowling, airscrews, controls, starting, gear, etc.	240
Engines, dry wt. at 750 lb. each	1,500
Oil, 10 galls. at 9 lb./gall. × 2	180
Oil tanks	10
Fuel, 150 galls. at 7.5 lb./gall. × 2 ..	2,250
Fuel tanks	150
Crew at 200 lb. each (4)	800
Total	10,000

20. The C.G.—Now that we have a provisional weight list, perhaps the most tricky part of the project can proceed. All the components and equipment, including engines, crew, fuel and oil, must be so disposed as to bring their combined C.G. to a position coinciding with the centre of pressure range of the wing section of the main wing. The C.G. is found by taking moments about a reference line placed preferably well forward of the stem of the boat, on the drawing (for fore and aft position of C.G.) and about a base line placed well below the keel (for the vertical position of the C.G.).

Note here that in order to reduce the metacentric height, and also to minimise the likelihood of porpoising troubles, the C.G. should be kept as low as possible. We usually find that quite a fair amount of juggling is needed in order to satisfy the centre of pressure—centre of gravity—main step position, demands.

21. Load Water Line.—It is necessary to mark on the layout the water line at the design load of 10,000 lb. To do this accurately, reference would have to be made to the hull lines, but as these will not be available at this stage of the work, a quick way is as follows: Find the length of the hull on the water line from

$$L^3 = \frac{0.67(\sqrt[3]{W})^4}{B} = \frac{0.67 \times (\sqrt[3]{10{,}000})^4}{6}\text{ft.}$$
$$= 28.84\text{ft. approx.}$$

Now mark this distance on the inclined line joining the C.G. with the main step heel (see para. 8), so that half (14.42ft.) is forward of the line and the other half behind. It is better to mark the 28.84ft. on a straight line drawn upon a separate piece of transparent paper, spotting on its mid-length. Then move it up the datum line, at 90 deg. to it, until it cuts the forebody and afterbody; mark this interception, and join up the two points and this will give the load water line position.

22. Concluding Details.—There are certain other points which merit attention in the project stage. A bow compartment complete with hatch in the top decking, should be provided, to facilitate picking up moorings, etc. Marine gear should be stowed here, such as boat hooks, anchor, mooring lines, etc. Access to the bow compartment should be as easy as possible from the interior of the hull.

An entry hatch should be provided either well above the water line aft of the wing trailing edge, or preferably in the top decking. There is some likelihood of the boat being wet inside if the entry door is in the hull side.

Having located the C.G. satisfactorily, it will be possible to form an idea as to where strong frames, water-tight compartments, etc., can be stationed. The structure at the main step, rear step, stern frame, wing fixings and tail unit attachments, can also be considered provisionally.

23. Conclusion.—It must be appreciated that from this stage the design, both aerodynamic and structural, really begins. It is almost certain that every point we have discussed will be rearranged and the basic project type bear little resemblance to the finalised design. The method of setting out on the design, *i.e.*, choosing a certain wing loading and working outwards, may be open to criticism as many would prefer to adhere to the method of choosing a lift coefficient C_L equal to something or other and building the wing design around the W or $L = C_L \frac{1}{2}\rho A V^2$ expression. There are other equally tricky ways of drafting out a project, but since the whole shooting match has to be changed once, changed twice, and changed again, any quick, easy method is looked upon favourably.

Although performance does not really concern us on the board, it is interesting to form an idea of what our boat could achieve in stalling speed, top speed, rate of climb, ceiling (service) and ceiling (absolute). As a rough guide to the top speed, the following formula may be used.

$$\text{Top speed} = F\sqrt[3]{\frac{w}{\lambda}}\text{ at sea level.}$$

In which "F" = a factor based upon analysis of known performances of similar boats and is equal to 140.

w = wing loading $= \frac{10000}{650} = 15.4$ lb./sq. ft.

λ = power loading $= \frac{10000}{800} = 12.5$ lb./h.p.

Then $V_{max} = 140\sqrt[3]{\frac{15.4}{12.5}} = 140\sqrt[3]{1.23}$.
$= 149.94$, say 150 m.p.h.

Since the top speed is usually about three times the stalling speed, the $V_{ST.} = \frac{156.8}{3} = 52$ m.p.h.

Using the charts and methods contained in M. Langley's "Seaplane Float and Hull Design," this design would appear to have an absolute ceiling of 15,000ft., a service ceiling of 13,000ft. and an initial rate of climb of 835ft./min.

Non-stop A.T.C.

TWO cadets of the Samford, Suffolk, Squadron A.T.C. cycle from Harwich three times a week to their instructional classes, a distance of 14 miles each way, and have never missed a parade.

The Samford Squadron covers an area of 25 small and scattered "front line" villages, where local buses, cycles, and even shanks's pony are essential links in the cadets' communications.

"Yet," their C.O. says, "despite the transport problems the cadets are rarely late, wet or fine."

Correspondence

The Editor does not hold himself responsible for the views expressed by correspondents. The names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

HOPE DEFERRED

Limited Capacity of Training Schools

I THINK "1516246" is looking at the question of his recall in the wrong light. The capacity of the training schools is obviously limited, and we must take our turn, hard as the period of waiting may be. I have been in the same position as your correspondent since February 6th, and although I am as keen as he to join a unit, I think we can rest assured that we are not being kept in "civvy street" for some unreasonable purpose. ["1717142."]

IDENTIFICATION FOR H.G.

Offer Still Under Consideration

IN reply to "Identification for H.G." in *Flight* correspondence (May 28th), prior to my discharge from the R.A.F. I instructed on aircraft recognition and signals at an E.F.T.S. Two local H.G. commanders enquired of my C.O. if I could be loaned to them to give their companies a course on recognition, to which my C.O. was only too pleased to agree.

Surely "Surrey" could work on the same lines, as I am certain that there must be airfields in his locality, and any R.A.F. instructor would not mind spending a couple of evenings a week, as I did, to help the H.G. R. SIMMONS
(Ex-Cpl., R.A.F.).

'SURREY'S" letter in *Flight* of May 28th on "Aircraft Identification" prompts me to reply, as this is a subject upon which I have been, until recently, lecturing to Army units. More than a year ago I offered to lecture to the Home Guard training centre at Denbies once a month, free, gratis and for nothing more than a railway warrant from London.

In view of the importance of the subject I do not think that this was an extravagant price to ask, but the question has been, and for all I know still is, "under consideration"; anyway, I have heard nothing further, and therefore I must conclude that your correspondent, like myself, has overestimated its value. G. FANE.

VAPOUR TRAILS

Long and Short Over Together

WITH regard to the correspondence on short vapour trails, I saw, during the Battle of Britain, a fighter squadron making long trails, which looked like railway lines, and another squadron making short trails, which looked like white tadpoles. These two occurrences took place within a space of ten minutes, at about the same height.

During the fight in which Wieck, the German fighter pilot, was killed, I again saw specimens of both types of vapour trail. The Nazis were making long trails over the I.O.W. in a confused pattern. Three "tadpole" trails flew south towards them, and a little later two squadrons of "tadpoles" flew west, a dozen miles north of the dogfight.

On both occasions the day was fine and hot, the aircraft were fighters, and they were at heights between 20-30,000ft.
A. McKEE.

"ODDITIES"

Is England Really so Foolish ?

WITH reference to "Oddities" by "Indicator," on page 537 in *Flight* of May 28th, 1942, the statement that anyone can land on an R.A.F. airfield without suspicion is manifestly absurd and far from convincing.

Let us suppose that a person in civilian life owned a Percival Vega Gull, and camouflaged it in the correct manner, took off and, shall we say, landed on an R.A.F. airfield somewhere in England. "Indicator" firmly believes that this person by sheer bluff would be looked upon as an Air Ministry official, or a "test pilot of great renown" (to quote his words), and would be able to stroll about the airfield and have a look at anything that might be of interest to him.

Surely, when this person landed in his Vega Gull, the officer commanding-in-chief of the airfield would be notified as to his presence and find out just why he had landed, and what strange mission he was on? Of course he would!

I am afraid if this person said he was on a scheduled flight to some other airfield, and that he had run out of petrol, the A.O.C. would immediately doubt him, as all aircraft are filled up with well over the amount of petrol needed for their journey. Perhaps "X" could convince the A.O.C. that he was in the Air Ministry, but what a predicament he would be in when asked to produce his papers, or at least his badge with, I think, the letters A.I.D. on it.

On the other hand, however, "X" might state he was a "test pilot of great renown," but I am sure the A.O.C. would be greatly amused by a test pilot flying a Vega Gull or any other type of aircraft that was privately owned before the war. What would a test pilot be doing, flying such a small machine as a Vega Gull?

I think with all this questioning, which, to my belief, would undoubtedly happen, "X" would not even be allowed to take off again until a thorough check up had been made establishing his identity and occupation, let alone have a walk round the station or factory as the case might be.

Theoretically, "Indicator" is definitely correct, but practically, "Indicator" is definitely incorrect.

Surely, "Indicator," with all his knowledge and experience, does not really believe that England is as foolish as he tries to make people believe, in *Flight* of May 28th? If England had not taken precautions against such things, I wonder what position she would have been in to-day. Not a very comfortable one, I can assure you. JOHN DARLINGTON.

CONCERNING GONGS

The Unnamed Sgt. Pilot

MAY I reply very briefly to the letter concerning "Gongs," contributed by C. Powell, in your issue of May 21st.

As I am the father of the "Sergeant Pilot" mentioned I must own that it left a nasty taste in my mouth; I would add that my son was decorated with the D.F.M. for work carried out with the two officers shown, and he was also informed in France that he was to be commissioned for his work. Incidentally, his commission did not arrive until six months after he left France.

With regard to the merits or de-merits of the D.F.M. and D.F.C., I would add that my boy always told me that he was more proud of his D.F.M. than he would have been of the D.F.C. He stated, rightly or wrongly, that the D.F.M. was harder to win, and, secondly, that it showed to all and sundry he had started at the bottom and worked his way up. Unfortunately, the said pilot is now posted missing, presumed killed in action; when lost he held the rank of Actg. Flt. Lt.
"FATHER."

POWER UNITS

The Search for More B.H.P.

MANY thanks for all the articles dealing with power units. I have enjoyed them immensely. I quite agree with the opinion expressed by your correspondent "R. P. G. J." that the trend of future design should be for more power for the same bore and stroke.

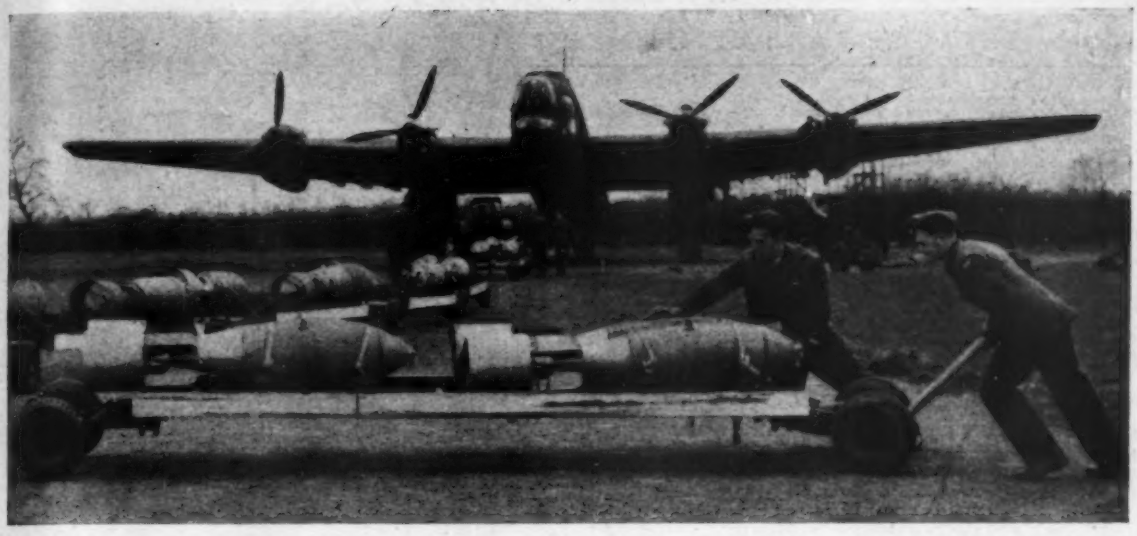
With this in view I have for some time past been engaged during my spare time in designing a unit to give a worthwhile increase in b.h.p. for any given bore and stroke.

I have accomplished this difficult task (on paper) to the extent of a b.h.p. increase of 80 per cent. on any *single acting* bore and stroke.

It now only remains for me to construct to two-cylinder unit to test my theory and to prove that the design in itself is capable of standing up to modern requirements.

Of one thing I am quite certain, and that is that the test unit will operate successfully and the power increase will be as stated, but whether the design will prove to be a commercial success only a complete thrashing of the test unit will disclose.

Once again I thank you for all the fine articles on the many subjects covered by aviation. J. W. M.



Loading up a Handley Page Halifax ready for the night's operations. A proportion of Halifaxes went to make up the " over 1,000 " raids on Cologne and Essen.

Service Aviation

Royal Air Force and Fleet Air Arm News and Announcements

Awards

THE KING has been graciously pleased to approve the following awards, in recognition of gallantry displayed in flying operations against the enemy :—

DISTINGUISHED SERVICE ORDER

Act. Wing Cdr. P. H. HUGO, D.F.C. and Bar, No. 41 Sqn.—This officer has completed over 500 hours' operational flying, a large proportion of which has been on patrols over enemy territory. During the autumn of 1941 he performed outstanding work in attacks on enemy shipping. He is a fine leader, and, during a period of five months from November, 1941, his unit destroyed at least twelve and damaged several more enemy aircraft. Both as squadron commander and wing leader this officer has displayed exceptional skill, sound judgment and fighting qualities which have won the entire confidence of all pilots in his command. He has destroyed 13 hostile aircraft and damaged a further seven.

Sqn. Ldr. J. A. F. MACLACHLAN, D.F.C. and Bar, No. 1 Sqn.—During the early part of the war this officer served in the Middle East, where he destroyed eight enemy aircraft. Following an injury, his left arm was amputated, but, within a few weeks, he was flying again. Since his return to England, Sqn. Ldr. Maclachlan has trained extensively in night flying operations, and he has achieved much success.

One night in April, 1942, he shot down a Dornier 217 over Northern France, and damaged another near an enemy airfield. One night in May, 1942, near Dinard, he destroyed a Dornier 217, and a few minutes later he shot down a Heinkel 111. The latter burst into flames on impact with the ground, causing a fire which could be observed from a distance of 10 miles. Sqn. Ldr. Maclachlan has attacked goods trains, trucks and barges with damaging effect. He is a gallant and skilful pilot, whose example is an inspiration to all pilots.

BAR TO THE DISTINGUISHED FLYING CROSS

Sqn. Ldr. R. M. B. DUKE-WOOLLEY, D.F.C., No. 124 Sqn.—This officer has participated in many sorties over Northern France and the English Channel. He is a cool and capable leader, whose skill is reflected in the high standard of efficiency in his squadron. He has destroyed at least seven enemy aircraft.

DISTINGUISHED FLYING CROSS

Act. Flt. Lt. R. D. CHURCH, R.C.A.F., No. 148 Sqn.—As an observer this officer has performed his operational tasks in an efficient and conscientious manner. He has at all times shown great keenness and courage, thereby setting an excellent example to his fellow-navigators. For the past three months he has fulfilled the duties of squadron navigation officer.

Sqn. Ldr. A. G. DOUGLAS, R.A.F.V.R., No. 401 (R.C.A.F.) Sqn.—This officer has completed over 100 operational sorties, of which 72 have been over enemy territory. He has destroyed two enemy aircraft, probably destroyed one, and damaged a further two. On one occasion, whilst over France, the port tailplane and starboard elevator of his aircraft were shot away, but he succeeded in flying back to base safely. In a recent engagement his aircraft was so severely damaged that he was compelled to abandon it. He was, however, flying on operations again the following day. Sqn. Ldr. Douglas has led his squadron with skill and determination.

Act. Flt. Lt. H. T. ARMSTRONG, R.A.A.F., No. 72 (Basutoland) Sqn.—This officer has participated in 29 operational sorties over enemy territory. He has destroyed at least five enemy aircraft and damaged a further two. Flt. Lt. Armstrong has displayed courage and initiative and his judgment and skill as a leader have contributed largely to the successes achieved by his flight.

Flt. Lt. T. BALMFORTH, No. 124 Sqn.—This officer was appointed to command a flight in September, 1941, and has since completed many major operations over hostile territory. He has destroyed one enemy aircraft, probably destroyed another and damaged a third. Flt. Lt. Balmforth has displayed coolness and enthusiasm which have set a magnificent example to others.

Flt. Lt. S. R. THOMAS, No. 264 Sqn.—Flt. Lt. Thomas has been engaged on operational flying since May, 1940. He has destroyed three enemy aircraft during daylight sorties and assisted in the destruction of a fourth. As a flight commander, engaged on night operations, he has completed 80 sorties. Flt. Lt. Thomas, through his outstanding enthusiasm, skill and devotion to duty, has contributed immensely to the general efficiency of his squadron.

Act. Flt. Lt. H. C. F. BOWMAN, R.A.F.V.R., No. 129 Sqn.—This officer has completed a large number of operational sorties, many of which have been over enemy territory. He is an exceptional pilot and a cool and skilful leader. He has destroyed three enemy aircraft and damaged a fourth.

Act. Flt. Lt. E. L. NEAL, R.C.A.F., No. 401 (R.C.A.F.) Sqn.—This officer has proved himself to be a skilful and determined pilot. He has participated in sweeps, convoy patrols and other operations. Throughout, he has displayed great keenness and set an inspiring example. On one occasion his aircraft was very extensively damaged

Flt. Lt. R. D. Church, R.C.A.F., No. 148 Squadron, who has been awarded the D.F.C. The official citation appears on this page.

SERVICE AVIATION

by enemy fire. Despite this, he skilfully landed it in a field. On another occasion, after several combats and when running short of petrol, he was forced to leave his aircraft by parachute whilst over the sea. He was rescued some two hours later. He has destroyed a Messerschmitt 109 and assisted in the destruction of another.

Act. Flt. Lt. J. C. ROBSON, R.A.F.V.R., No. 118 Sqn.—This officer has been engaged on operational flying since November, 1940. He has completed a large number of sorties, many of which have been over enemy-occupied territory. He has also participated in three daylight attacks on German battleships. Flt. Lt. Robson has displayed great keenness to engage the enemy and has set an excellent example.

P/O. A. A. GLEN, R.A.F.V.R., No. 41 Sqn.—This officer has at all times shown the greatest keenness to engage the enemy, and he has played a large part in the squadron's activities during recent months. Besides destroying at least three enemy aircraft in combat, P/O. Glen has attacked many targets, causing much damage to the enemy.

P/O. I. C. ORMSTON, R.C.A.F., No. 401 (R.C.A.F.) Sqn.—This officer has completed many sweeps, convoy patrols and other sorties. He has destroyed three enemy aircraft, probably destroyed one and assisted in the destruction of another. He has displayed exceptional keenness to engage the enemy.

Act. Wing Cdr. J. P. RYLAND, R.A.A.F., No. 13 Sqn.—This officer was appointed to command the advanced operational base at Namlea in the Moluccas, early in December, 1941, and, later during that month, assumed command of No. 13 Sqn. at Ambon, off Serang. He took an active part in reconnaissance duties against the enemy and obtained much valuable information. He led every raid made by his squadron against Menada, Celebes, where enemy shipping was successfully attacked and bombed. From Ambon he completed approximately 250 hours' operational flying against the enemy.

After leaving Ambon, immediately prior to the Japanese occupation, the squadron returned to Australia, and from there has since continued its reconnaissance duties and attacks against the enemy. In the course of these attacks Wing Cdr. Ryland led an extremely successful night raid against Japanese-occupied Dili, Timor. His devotion to duty whilst flying, his personal courage and determination displayed in the face of heavy odds, proved the inspiration of all under his command.

Flt. Lt. R. A. DUNNE, R.A.A.F., No. 13 Sqn.—This officer was one of the original party which moved to Ambon early in December, 1941, and remained there until the time of the enemy occupation at the end of January, 1942. While stationed at Ambon he continuously led his flight in operations against the enemy and took part in numerous reconnaissance flights and raids upon enemy shipping at Menada and Kema, Celebes enemy assembly bases. In these operations he completed over 200 hours' operational flying.

When leading a flight in formation on the raid on the Japanese base at Tobi Island, his Squadron Leader crashed but Flt. Lt. Dunne unhesitatingly took command and successfully completed the original mission. On many raids completed by him against the enemy, when losses were high owing to strong fighter opposition and ground fire, he set the highest example of devotion to duty, leading his flight with courage, vigour, determination and complete disregard for his personal safety. Since the return of his squadron to Australia he has continued to take part in seaward reconnaissances and has led successful raids against the enemy at Koepang, Timor.

F/O. W. V. D. WHITE, R.A.A.F., No. 2 Sqn.—This officer has completed a number of sea reconnaissances from Australia and other flights of a reconnaissance character in operating against the enemy in the Celebes-Ambon area, including a continuous reconnaissance of the large invasion fleet, which was strongly supported by fighter aircraft. Despite frequent attacks, F/O. White courageously, persistently, and with outstanding skill, continued his reconnaissance until the enemy were within 10 miles of their objective.

Although his aircraft was so seriously damaged that it could no longer be flown, his successful reconnaissance enabled the land forces to occupy the most favourable positions possible prior to attack. F/O. White's actions during this trying and difficult period constituted an epic story of courage, determination, skill and devotion to duty.

Sqn. Ldr. T. H. BINGHAM-HALL, No. 150 Sqn.—This officer has commanded a flight and has completed many successful sorties over Germany, Italy and the occupied countries. During the winter months many of his flights have been completed in very adverse weather, but he has shown great perseverance in locating and bombing his target. In March, 1942, when crossing the English coast on the outward journey, his wireless became unserviceable, but he completed his mission and, despite adverse weather, returned to base safely.

Sqn. Ldr. (now Act. Wing Cdr.) G. G. STEAD, No. 204 Sqn.—This officer, who has completed over 6,000 hours flying, of which over 800 hours is operational, has outstanding ability. He is the most brilliant and reliable pilot and navigator in the Squadron, who through his qualifications has always been given the hardest tasks calling for special skill. He has carried out operations from Shetlands, Iceland, the Mediterranean and West Africa under all conditions by day and night.

Sqn. Ldr. E. A. WARFIELD, R.A.F.O., No. 57 Sqn.—Sqn. Ldr. Warfield has participated in operational sorties against targets in Germany and occupied territory and has displayed great perseverance in locating and bombing his target, from low altitudes, despite adverse weather and fierce opposition. His keenness and devotion to duty have had a most inspiring effect on his crews and have contributed largely to the maintenance of a high standard of morale in his flight.

Act. Sqn. Ldr. L. MACD. HODGES, No. 49 Sqn.—Sqn. Ldr. Hodges served with the squadron in France, in 1940, when he displayed gallantry and determination. Since August, 1941, he has commanded a flight and has completed many operational missions, some of which have been undertaken in daylight. Many of these sorties have been completed in the face of most adverse weather and strong opposition from the enemy. Despite these difficulties, Sqn. Ldr. Hodges has frequently remained in heavily defended areas, for considerable periods, in order to ensure positive identification of his target before bombing.

Flt. Lt. R. V. GASCOYNE-CECIL, R.A.F.V.R., No. 61 Sqn.—This pilot completed two operational sorties before joining his present unit. He has consistently displayed outstanding ability and determination in locating his targets and in pressing home his attacks in adverse weather and despite heavy opposition.

Act. Flt. Lt. L. R. BARR, No. 15 Sqn.—This officer has participated in sorties against Berlin, Bremen, Pilsen, Wilhelmshaven, Brest and Kiel, and has displayed great keenness and devotion to duty throughout. One day in January, 1942, he was the captain of an aircraft which was attacked by a series of enemy fighters and despite the fact that three of his crew were wounded in the initial attacks Flt. Lt. Barr succeeded in evading the enemy and returned to base safely.

Act. Flt. Lt. J. S. BELTON, R.A.F.V.R., No. 77 Sqn.—This officer maintained a high standard of keenness and devotion to duty. His cheerful disposition and outlook have always been an asset to squadron morale.

Act. Flt. Lt. W. P. FERRIE, R.A.F.V.R., No. 50 Sqn.—Flt. Lt. Ferrie has completed 27 sorties as captain of aircraft. One day in August, 1941, he was detailed to bomb a target at Mannheim and despite intense anti-aircraft fire he descended to a low level to ensure hits on his target. Flt. Lt. Ferrie has at all times set a splendid example of cheerful devotion to duty and he has been an inspiration to the whole squadron.

Act. Flt. Lt. J. B. G. KING, R.A.F.V.R., No. 50 Sqn.—Flt. Lt. King completed successfully a number of sorties as navigator. He was then appointed captain of aircraft and has now completed a further number of operational flights, displaying gallantry and outstanding devotion to duty. He has participated in raids against many targets in Germany and was one of a crew selected for the combined operation against Vaagso. On this occasion he was detailed to lay a smoke screen and he also

Armourers sorting out the load of a Stirling. The bombs have to be put in the racks in a certain order so as to make up the proper sequence of sticks.

H.R.H. The Duke of Kent with Air Marshal Sir Leslie Gossage at the exhibition of paintings by members of the Balloon Command.

SERVICE AVIATION

machine-gunned and silenced a German battery by repeated attacks from a very low level.

Act. Flt. Lt. N. A. J. MACKIE, R.A.F.V.R., No. 83 Sqn.—This officer has completed many sorties first as navigator and then as captain. He has displayed the most commendable determination in locating and attacking his target in adverse weather. Recently, while engaged in an anti-shipping sortie, he made two attacks from mast height scoring hits with his bombs and raking a ship with machine gun fire. Despite the fact that his aircraft was severely damaged, he pressed home his attack.

P/O. L. J. GRANDY, R.A.F.V.R., No. 12 Sqn.—This officer has displayed exceptional ability as an observer. On one occasion, when returning from Stettin, in very bad weather, he navigated his aircraft to the nearest airfield in this country, where a successful landing was made, almost without petrol. After a long period of valuable operational flying he has been appointed squadron bombing leader, a duty he is performing exceptionally well.

P/O. P. A. MACKENZIE, R.A.F.V.R., No. 83 Sqn.—P/O. Mackenzie has completed many sorties, first as navigator and later as captain, against heavily defended targets, which have included Hamburg, Cologne, Kiel and Essen. On all occasions, often in very bad weather and intense enemy opposition, by his determined efforts and skilful airmanship, he has located and bombed his targets successfully.

DISTINGUISHED FLYING MEDAL.

Flt. Sgt. G. ROBERTS, No. 200 Sqn.—Flt. Sgt. Roberts has been employed operationally as a wireless operator/air-gunner since the commencement of hostilities. This includes many operational sorties on convoy escort, offensive patrols, searches and bombing raids. In August, 1940, he destroyed a He.115 off the Dutch coast from the turret of a Hudson aircraft. Flt. Sgt. Roberts is an excellent N.C.O., with a keen sense of discipline and devotion to duty.

Flt. Sgt. D. W. SPIBY, No. 106 Sqn.—Flt. Sgt. Spiby has participated in numerous operational sorties, including daylight patrols and sweeps, attacks on enemy positions during the invasion of France, bombing of Channel ports and raids on the Ruhr, Berlin, Leuna and Bordeaux. He has also taken part in successful attacks against Hamburg and Kiel. Flt. Sgt. Spiby is a wireless operator of outstanding ability, and has rendered invaluable assistance to his navigator.

Flt. Sgt. F. TAYLOR, No. 58 Sqn.—This airman has proved himself to be a wireless operator/air-gunner of outstanding ability. His keenness and devotion to duty have contributed largely to the success of the crews with whom he has operated. Flt. Sgt. Taylor has also acted as an instructor with considerable success.

Flt. Sgt. R. E. WALKER, No. 103 Sqn.—This navigator has at all times displayed great gallantry and a fine sense of responsibility whilst under fire and in the face of danger. His cheerful confidence has contributed largely to the high standard of his crew. He has, on numerous occasions, successfully navigated his aircraft to the target and back without wireless aid. One night he navigated his aircraft in intense darkness, and when ground fog necessitated its abandonment by parachute when over base he organised the crew until they had all left, and finally jumped just before the captain. On another occasion, when it was necessary for the aircraft to be crash-landed at base, he displayed similar fearless and cheerful conduct.

Flt. Sgt. J. C. BECK, No. 61 Sqn.—Flt. Sgt. Beck is a most reliable wireless operator/air-gunner, whose ability, combined with exceptional keenness, has contributed largely to the successes achieved by his crew. On one occasion when his aircraft was attacked by an enemy fighter, and he was wounded in the hand, he remained at his guns, returning the fire, and drove the attacker off.

Sgt. I. BOOT, No. 61 Sqn.—This airman has proved himself to be a most reliable wireless operator/air-gunner, who has contributed materially to the success of the operations on which he has been engaged.

Sgt. H. COBB, No. 144 Sqn.—Sgt. Cobb, an observer, has been detailed to attack many important and heavily defended objectives in Germany, a task which he has completed successfully. He has displayed gallantry and devotion to duty and a strong determination to press home his attacks.

Sgt. G. H. DOW, R.N.Z.A.F., No. 57 Sqn.—Sgt. Dow has attained a high standard as a navigator and bomb-aimer. His operations, which include a daylight attack on Brest, have been successfully completed, often in adverse weather.

Sgt. J. M. DUNCAN, R.A.F.V.R., No. 207 Sqn.—As wireless operator/air-gunner, Sgt. Duncan has participated in many successful sorties, including attacks on Brest, Kiel and St. Nazaire. His team work is excellent, and he displays enthusiasm and efficiency in the face of danger. On one occasion he obtained radio navigational aid under exceptionally difficult circumstances, whilst still well over enemy territory, which contributed largely to the safe return of the aircraft.

Sgt. D. W. FOSTER, No. 58 Sqn.—This airman has proved himself to be a wireless operator/air-gunner of outstanding ability. His keenness and devotion to duty have contributed largely to the success of the crews with whom he has operated.

Sgt. C. F. GUEST, No. 144 Sqn.—Sgt. Guest has participated in many operational flights in extremely bad weather, and has displayed gallantry and devotion to duty of a high standard.

Sgt. P. M. P. HALL, No. 106 Sqn.—Sgt. Hall has participated in attacks on many heavily defended targets in Germany and in daylight raids, including an attack on a French power station and on the German battleship *Gneisenau* at Brest. As wireless operator/air-gunner he has shown outstanding ability, and his keenness and devotion to duty have contributed largely to the successes achieved and to the safe return of the aircraft.

Sgt. H. G. LINES, No. 57 Sqn.—Sgt. Lines, a wireless operator/air-gunner, has participated in operational flights over Kiel, Brest, Essen, Hamburg, Mannheim and Bremen, and has proved to be a keen and reliable member of an air crew. His cheerfulness and courage, in the face of heavy enemy opposition, have been outstanding.

Sgt. F. MCMULLEN, No. 51 Sqn.—This airman, as a wireless operator/air-gunner, has taken part in many attacks on targets in Germany and Occupied France. On several occasions when attacked by enemy fighters, Sgt. McMullen's skill and coolness have been materially responsible for the safe return of his aircraft.

Sgt. A. MARVELL, No. 33 Sqn.—This wireless operator/air-gunner has participated in attacks against targets at Bremen, Emden, Mannheim, Hamburg and Brest. The skill and speed with which he has manipulated his wireless set have proved him to be a most useful member of an air crew. He has, at all times, displayed keenness and devotion to duty, and has contributed largely to the high standard maintained by his crew.

Sgt. G. E. MORTIMER, No. 10 Sqn.—Sgt. Mortimer, who has served with the squadron since March, 1941, has displayed great gallantry as a wireless operator/air-gunner. On one occasion, when his aircraft was attacked by an enemy fighter, Sgt. Mortimer succeeded in destroying the attacker. When not engaged on operational duties he has displayed keen interest in the training of junior air crew personnel.

Sgt. O. W. J. PEARCE, No. 61 Sqn.—Sgt. Pearce, a wireless operator/air-gunner, has on three occasions been compelled to abandon his aircraft by parachute on returning from operational duty. He has consistently displayed keenness and devotion to duty, and has contributed materially to the success of the operations in which he has participated.

Sgt. N. C. ROBERTSON, No. 50 Sqn.—Sgt. Robertson, a wireless operator/air-gunner, has completed many successful sorties on primary targets. He participated in the combined operation on Vaagso, where he bombed gun emplacements from a very low level. During this attack the navigator in his aircraft was seriously wounded, and Sgt. Robertson rendered first aid, which undoubtedly saved the life of the navigator. On February 12th, 1942, when attacking the German battleships on their dash through the English Channel, the aircraft was severely damaged by anti-aircraft fire. Sgt. Robertson assisted the pilot to maintain control of the aircraft, and obtained wireless fixes which enabled it to be flown to base safely. His cheerful calmness in the face of danger is a continual inspiration to his crews and squadron.

Sgt. R. VIVIAN, No. 9 Sqn.—One night in August, 1941, this airman was the rear gunner in a Wellington aircraft detailed to bomb a target at Hanover. The aircraft was attacked by a Junkers 88, and the rear turret was rendered unserviceable by cannon fire. Sgt. Vivian, although almost blinded by searchlights, succeeded in operating his guns by hand, and eventually drove the enemy aircraft off. On another occasion he probably destroyed an enemy fighter over the English coast when on his way to bomb Frankfurt.

Sgt. J. WYNN, No. 144 Sqn.—Sgt. Wynn has participated in many successful sorties, including targets at Brest, Hamburg, Mannheim and Wilhelmshaven. As a wireless operator, he has maintained a very high standard of work both on the ground and in the air.

Sgt. A. D. L. YARNELL, No. 58 Sqn.—This airman has proved himself to be a wireless operator/

ONE MORE OVER: The crew of a Consolidated Liberator which has just been delivered to a Ferry Command base after flying the Atlantic.

Parade ground precision. A demonstration of the slow march by newly commissioned officers of the W.A.A.F.

SERVICE AVIATION

air-gunner of outstanding ability. His keenness and devotion to duty have contributed largely to the success of the crews with whom he has operated.

Foreign Decoration

HIS MAJESTY THE KING has granted unrestricted permission for the wearing of the undermentioned decorations, conferred on the officers indicated, in recognition of valuable services rendered in connection with the war:—

CONFERRED BY THE PRESIDENT OF THE POLISH REPUBLIC.

Polonia Restituta—Second Class.

Air Marshal Sir W. S. DOUGLAS, K.C.B., M.C., D.F.C.
Air Marshal Sir R. E. C. PEIRSE, K.C.B., D.S.O., A.F.C.
Air Vice-Marshal T. L. LEIGH-MALLORY, C.B., D.S.O.
Act. Air Vice-Marshal R. D. OXLAND, O.B.E.

Third Class.

Air Comdre H. K. THOROLD, C.B.E., D.S.C., D.F.C., A.F.C.

Fourth Class.

Act. Wing Cdr. H. C. BILES, R.A.F.V.R.
Act. Wing Cdr. W. B. EVERTON.

Roll of Honour

Casualty Communique, No. 135.

THE Air Ministry regrets to announce the following casualties on various dates. The next-of-kin have been informed. Casualties "in action" are due to flying operations against the enemy; "on active service" includes ground casualties due to enemy action, non-operational flying casualties, fatal accidents and natural deaths.

In the briefing room. Air crews of a Boston III squadron get their instructions for the day's "ops."

Royal Air Force

KILLED IN ACTION.—F/O. P. K. Crowther; Sgt. E. Goodfellow; Sgt. J. Hardy; Sgt. G. C. S. Skelton; P/O. H. Neal; Sgt. R. O'Donnell; Sgt. R. R. Pole; F/O. R. Seely-King; Sgt. G. L. Quincey.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—Sgt. J. R. Anyan; Sgt. A. J. Dickerson; Sgt. L. G. C. Dimond; P/O. J. G. S. Gardiner; Sgt. C. Murch; Sgt. K. Naylor; Sgt. D. H. Stronach; Sgt. D. E. Williams; Sgt. D. A. Willison; Sgt R. McK. Young.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. D. A. Bartrip; Sgt. D. Beale; Sgt. J. H. Blunt; Sgt. P. J. Brady; Sgt. J. E. Chadwick; Act. Flt. Lt. R. J. Chamberlain, D.F.C.; Flt. Sgt. J. Collins; Sgt. F. H. E. Dearden; Sgt. C. T. Everitt; Sgt. S. J. Fenson; Flt. Sgt. H. Hamer; P/O. C. J. Harper; W/O. S. Howarth; P/O. H. D. C. Henderson; Flt. Lt. C. F. Irving; Sgt. F. L. C. Jewell; Sgt. L. G. Manning; Act. Flt. Lt. M. J. Miller; Sgt. G. S. Needler; Sgt. D. G. Pack; P/O. J. B. Patterson; Sgt. D. Poulston, Sgt. M. S. Proce; Sgt. E. H. Roff; Sgt. F. P. Stewart; P/O. G. E. Sweeney; Flt. Sgt. W. Trotter; Sgt. E. Waller; P/O N. P. Warden; Sgt. B. F. Widdecombe.

WOUNDED OR INJURED IN ACTION.—P/O. E. Andrews; Sgt. G. F. Mackay; Act. Flt. Lt. P. W. E. Heppell, D.F.C.; Sgt. N. J. Stronell.

DIED OF WOUNDS OR INJURIES RECEIVED IN ACTION.—Flt. Lt. P. J. A. Byers; Flt. Sgt. T. G. Paxton.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. E. T. Albrighton; Sgt. J. H. Alexander; P/O. C. H. Danielsen; Sgt. E. Dixon; Sgt. V. A. L. Ellis; P/O. D. R. Hart; P/O. J. McK. Henderson; Sgt. A. G. Jaye; Sgt. W. J. Lambie; Sgt. P. Markides; Sgt. T. H. Miller; Sgt. H. Mitchell; Sgt. J. Murphy; Sgt. S. Perry; Sgt. R. A. Pratt; Sgt. A. G. Richards; Sgt. R. Sangster; Flt. Sgt. G. J. Sheahan; Sgt. C. C. Smith; Sgt. E. K. Stevens; Flt. Sgt P. G. Thorpe; Cpl. W. H. Wallett; Sgt. R. T. Ward; Sgt. A. Woodcock.

MISSING.—Sgt. W. Ballard; Sgt. R. H. J. Barrie; Sgt. J. S Beauchamp; Act. Flt. Lt. E. M. Bury; Sgt. H. Chaplin; Sgt. T. Crilly; Sgt. B. J. Dove; Sgt. D. I. Dunn; Sgt. A. F. M. Emms; Wing Cdr. A. Golding, D.F.C.; Sgt. J. F. Grimmett; Sgt. E. C. Groves; Sgt. J. Hand; P/O. R. L. Hayes; Sgt. A. Jelly; Sgt. S. M. Jones; Sgt. E. Lawrence; Sgt. W. R. Lea; Sgt. W. E. Lucan; Sgt. W. S. Makin; P/O. J. Marr; Sgt. R. W. Page; Sgt. J. R. Payne; Sgt. P. Robinson; Sgt. L. D. Sollars; Sgt. L. C. Stanley; Sgt. H. L. Suckling; Sgt. F. G. Tapner; Sgt. C. J. N. Watkin; Sgt. D. J. White; Sgt. P. Wilson.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Sgt. P. G. Cannell; Sgt. C. Carling; Flt. Sgt. J. H. Hibert; P/O. J. D. Mair; Flt. Sgt G. P. Rylands.

KILLED ON ACTIVE SERVICE.—L.A/C. T. W. Atkin; Sgt. E. R. Baggot; Cpl. G. L. Barclay; Sgt. H. J. Beck; Sgt. E. J. Biddulph; Act. Sgt. A. E. Bloor; A/C.2 A. C. Campbell; Sgt. J. H. Carr; Sgt. H. Clarke; Act. Sqn. Ldr. D. E. Cremin, D.F.C.; L.A/C. R. E. Davies; Sgt. G. A. Edmonds; P/O. J. H. Ellis; L.A/C. H. T. Gallichan; A/C.1 J. G. Godden; A/C.2 R. W. Hailstone; P/O. H. W. Hart; L.A/C. T. H. Hedger; Sgt. G. Horton; Sgt. D. Lees; Sgt. W. Luney; L.A/C. F. Nash; Sgt. B. Noseworthy; P/O. J. S. Nowell; Sgt. G. E. Peart; P/O. P. M. Rudgard; F/O. H. K. Smith; Sgt. A. J. Snook; Sgt. R. W. Soper; A/C.1 E. R. Wakeham; A/C.1 L. M. Waldren.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—L.A/C. E. S. Copplestone.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. E. H. Brace; Sgt. G. W. Gray; Sgt. L. H. Oldman.

WOUNDED OR INJURED ON ACTIVE SERVICE.—L.A/C. J. W. De Quincey; Sgt. W. J. Fry; P/O. C. H. Grant; F/O. A. J. Smith; L.A/C. J. Smith; Sgt. R. G. W. Swan.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—Sgt. A. J. A. Dodd; Act. Flt. Lt. E. P. Edsall, D.F.C.; Sgt. R. M. Jenkins; Sgt. J. S. Salmond, L.A/C. R. A. F. Shortbolt.

DIED ON ACTIVE SERVICE.—Cpl. F. C. Barnes; L.A/C. H. Blomenkranz; F/O. G. C. R. Franks; A/C.1 S. Green; A/C.2 G. W. D. Harmer; Cpl. E. Hunter; L.A/C. J. Kyle; Sgt. W. J. Parsons; Act. Cpl. J. H. Rylatt.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. R. Clark; Sgt. C. Dancer; Sgt. R. O. R. Morgan; Sgt. C. A. Pacey; P/O. M. G. M. Reid; Sgt. J. Sackfield.

Women's Auxiliary Air Force

WOUNDED OR INJURED ON ACTIVE SERVICE.—Flt./O. M. E. Wallace.

DIED ON ACTIVE SERVICE.—A/CW.2 L. H. Pitts-Tucker; A/CW.2 D. E. Thornton.

Royal Australian Air Force

KILLED IN ACTION.—P/O. G. E. Caswell; P/O J. W. Evatt; Sgt. H. N. Walker.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. R. M. Hamilton.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—Sgt. A. MacG. Wilson.

PREVIOUSLY REPORTED MISSING, NOW REPORTED KILLED IN ACTION.—Sgt. H. C. Kerr.

WOUNDED OR INJURED IN ACTION.—F/O. J. L. Tully.

MISSING, BELIEVED KILLED IN ACTION.—Sgt. R. M. Herman; P/O. D. McConachie; Sgt. F. D. McLeod.

MISSING.—Sgt. D. I. Bloomfield; Sgt. W. I. Christsen; P/O. E. W. C. Creed; P/O. M. R. R. Green; P/O. J. B. Maher; Sgt. W. W. R. Norton; Sgt. T. E. Parsons; Sgt. C. W. L. Pooley; P/O. J. A. Weller.

MISSING, BELIEVED KILLED ON ACTIVE SERVICE.—Act. Flt. Lt. H. K. Keck.

KILLED ON ACTIVE SERVICE.—Sgt. V. G. H. Copas; Sgt. R. V. Daniels; Sgt. W. D. Norman.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW PRESUMED KILLED ON ACTIVE SERVICE.—P/O. J. E. Hiller.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED ON ACTIVE SERVICE.—P/O. J. D. B. Rowlands.

PREVIOUSLY REPORTED MISSING, NOW REPORTED PRISONER OF WAR.—Sgt. M. H. C. Berrie.

Royal Canadian Air Force

KILLED IN ACTION.—F/O. E. W. R. Fortt; Flt. Sgt. S. J. Kozlowski.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED IN ACTION, NOW PRESUMED KILLED IN ACTION.—P/O. W. K. Colfe; Sgt. J. A. Jacques; Sgt. F. C. Stephenson.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. J. G. Elliott; Sgt. T. C. Fitzgerald; Sgt. G. E. Findlay; Sgt. J. S. Lappin; P/O. A. O. Learmonth; Sgt. W. R. Sutherland; P/O. D. B. Van Buskirk; Flt. Sgt. C. A. Whidden.

MISSING, BELIEVED KILLED IN ACTION.—P/O. T. Best; Flt. Sgt. M. Duncan; Sgt. A. L. Flesch; P/O. K. E. Hobson; Flt. Sgt. F. J. Lowe; Sgt. E. A. Mullis; Flt. Sgt. W. D. Page.

MISSING.—Flt. Sgt. B. E. Doe; L.A/C. J. Molnar; Sgt. A. Lennox; P/O. J. McL. Murdock; P/O. W. F. Munn; Sgt. W. M. Pipher; Sgt. C. W. Starrett.

KILLED ON ACTIVE SERVICE.—Sgt. N. G. W. Boyce; Sgt. L. N. Brown; Sgt. R. C. Dobie; Flt. Sgt. G. S. Gould; Sgt. H. J. Helbock; Sgt. R. Jeffery; Sgt. D. C. Lindsey; Sgt. R. J. O'Leary.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED ON ACTIVE SERVICE.—Sgt. A. G. Batchen; Flt. Sgt. R. F. Stephens; Flt. Sgt. R. L. R. Younger.

PREVIOUSLY REPORTED MISSING, BELIEVED KILLED ON ACTIVE SERVICE, NOW REPORTED KILLED ON ACTIVE SERVICE.—Sgt. J. R. Pierce.

WOUNDED OR INJURED ON ACTIVE SERVICE.—Sgt. J. W. Asselstine; Act. Flt. Lt. W. F. Napier; Sgt. D. L. Rawson.

DIED OF WOUNDS OR INJURIES RECEIVED ON ACTIVE SERVICE.—P/O. J. R. Moore.

Royal New Zealand Air Force

KILLED IN ACTION.—Sgt. H. J. McNeill.

PREVIOUSLY REPORTED MISSING, NOW PRESUMED KILLED IN ACTION.—P/O. D. Brook; P/O. E. W. G. Churches; Sgt. G. G. Jillett; Sgt. E. R. Lucas; Sgt. A. W. Simpson.

WOUNDED OR INJURED IN ACTION.—Flt. Sgt. J. M. Smith.

KILLED ON ACTIVE SERVICE.—Sgt. A. W. Westgate.

South African Air Force

KILLED IN ACTION.—Lt. M. J. Bartels.